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A BRIEF LIST OF WORKS ON METEOROLOGY

Compiled by Richmond T. Zoch

POPULAR AND ELEMENTARY WORKS

Boy Scouts of America. Weather. New York. 1928. (Merit badge series 3816.) [By W. J. Humphreys and C. F. Talman.]
Brooks, Charles F. Why the weather? Rev. and enl. New York. 1935.
Brooks, C. E. P. The weather. London. 1927.
Brunt, David. Meteorology. London. 1928.
Brunt, David. Weather science for everybody. London. 1936.
Defant, A. Meteorologie. Berlin. 1929.
Ficker, H. von, Wetter und Wetterentwicklung. Berlin. 1932.
Humphreys, W. J. Weather Rambles. Baltimore. 1937.
Pick, W. H. A short course in elementary meteorology. 4th ed. London. 1933. (Great Britain, Meteorological Office. M. O. 247.)
Pickwell, Gale. Weather. Los Angeles, 1937.
Rouch, J. L'Atmosphère et la prévision du temps. Paris. 1923.
Shaw, Sir Napier. The drama of weather. Cambridge. 1933.
Talman, Charles Fitzhugh. A book about the weather. New York. 1935. [Previously published as: The realm of the air. Indianapolis. 1931.]
Talman, Charles Fitzhugh. The story of our weather. New York. 1930. [Previously published as: Our weather: what makes it and how to watch it. (A volume in Collier's Popular Science Library.) Also as Meteorology, The science of the atmosphere. 1922.]
Trewartha, Glenn T. An introduction to weather and climate. New York, 1937.
Watt, R. A. Watson. Through the weather house. London. 1935.

GENERAL TREATISES

Angot, Alfred. Traitè èlèmentaire de mètèorologie. 4th ed. Paris. 1928.
Blair, Thomas A. Weather elements. New York, 1937.
Börnstein, R. Leitfaden der wetterkunde. 4th ed. Braunschweig. 1927.
Geddes, A. E. M. Meteorology; an introductory treatise. London. 1921.
Hann, J. von, & Süring, R. Lehrbuch der meteorologie. 4th ed. Leipzig. 1926. (5th ed. Now in course of publication in parts.)
Humphreys, William J. Physics of the air. 2d ed. New York. 1929.
Linke, Franz, ed. Meteorologisches Taschenbuch. 2 vols. Leipzig. 1931–1933.
Milham, Willis I. Meteorology. New York. 1912.
National research council. Physics of the earth. III. Meteorology. Washington. 1931.
Shaw, Sir Napier. Manual of meteorology. 4 vols. Cambridge. 1926–1931. (2d vol. revised 1936.)
Süring, R. Leitfaden der meteorologie. Leipzig. 1927.

CLOUDS

Clarke, George A. Clouds. London. 1920.
Clayden, Arthur William. Cloud studies. 2d ed. London. 1925.
Great Britain, Meteorological office. Cloud forms according to the international classification. 3d ed. London. 1934.
Humphreys, William J. Fogs and clouds. Baltimore. 1926.
International meteorological committee. International atlas of clouds and of states of the sky. Paris. Abridged ed. for the use of observers. 1930. Complete ed. I. General atlas; II. Atlas of tropical clouds. 1932.
Süring, R. Die wolken. Leipzig. 1936.

DYNAMIC METEOROLOGY

Abbe, Cleveland. The mechanics of the earth's atmosphere. A collection of translations. (2d collection). Washington. 1891. Third collection. Washington. 1910. [Published by Smithsonian institution.]
Bjerknes, V. et al. Physikalische Hydrodynamik, mit anwendung auf die dynamische meteorologie. Berlin. 1933. (Also translated into French.
Brillouin, M. Mémoires originaux sur la circulation générale de l'atmosphère. Paris. 1900.
Brunt, David. Physical and dynamical meteorology. Cambridge. 1934.
Carnegie institution of Washington. Publication no. 88. Bjerknes & Sandstrom. Pt. I Statics. 1910. Hesselberg & Devik. Pt. II. Kinematics. 1911.
Ertel, H. Methoden und probleme der dynamischen meteorologie. Berlin. 1938.
Exner, Felix M. Dynamische meteorologie. 2d ed. Wien. 1925.
Ferrel, William. Recent advances in meteorology. Washington. 1886. (Annual report of the Chief Signal Officer. 1885. Appendix 71.)
Hildebrandsson, H., & Teisserenc de Bort, L. Les Bases de la météorologie dynamique. 2 vols. Paris, 1898–1907.
Koschmieder, H. Dynamische meteorologie. Leipzig. 1933.
Sprung, A. Lehrbuch der meteorologie. Hamburg. 1885.
Wegener, A. Thermodynamik der atmosphäre. Leipzig. 1911.

WEATHER AND WEATHER FORECASTING

Abercromby, Ralph. Weather; the nature of weather changes from day to day. Revised by A. H. R. Goldie. London. 1934.
Baldit, Albert. Etudes élémentaires de météorologie pratique. Paris. 1922. Deuxième édition.
Bliss, George S. Weather forecasting. 5th ed. Washington. 1929. (U. S. Weather Bureau. Bull. 42.)
Byers, H. R. Synoptic and aeronautical meteorology. New York. 1937.
Defant, Albert. Wetter und Wettervorhersage. 2d ed. Leipzig. 1926.
Georgii, Walter. Wettervorhersage; die fortschritte der synoptischen meteorologie. Dresden. 1924.
Great Britain, Meteorological Office. The weather map; an introduction to modern meteorology. 2d ed. London. 1930.
Henry, Alfred Judson. Weather forecasting from synoptic charts. Washington. 1930. (U. S. Dept. of Agriculture. Miscellaneous publication no. 71.)
Kassner, Carl. Das wetter und seine bedeutung für das praktische leben. 2d ed. Leipzig. 1918.
Namias, Jerome, and others. An intriduction to the study of air mass analysis. Milton, Mass. The American Meteorological Society. 3rd ed. 1936.
Petterssen, Sverre. Kinematical and dynamical properties of the field of pressure with application to weather forecasting. Oslo. 1933.
Petterssen, Sverre. Practical rules for prognosticating the movement and the development of pressure centers. Bergen. 1933. (Mimeographed.)
Rouch, J. Les méthodes de prévision du temps. Paris. 1924.
Sanson, J. La prévision du temps en agriculture. Paris. 1925.
Schmauss, A. Das problem der wettervorhersage. 2d ed. Leipzig. 1937.
Shaw, Sir Napier. Forecasting weather. 2d ed. London. 1923.
U. S. Weather Bureau. Weather forecasting in the United States. Washington. 1916.

Van Mieghem, J. Prévision du temps par l'analyse des cartes météorologiques. Paris. 1936.
Weightman, R. Hanson. Forecasting from synoptic weather charts. Washington. 1936. (U. S. Dept. of agriculture. Miscellaneous publ. 236.)

AERONAUTICAL METEOROLOGY

Baldit, A. Les routes aeriennes de l'Atlantique. Paris. 1928.
Dedebant, G., and Viant, A. Manuel de météorologie du pilote. Paris 1936.
Georgii, Walter. Flugmeteorologie. Leipzig. 1927.
Gregg, Willis Ray. Aeronautical meteorology. 2d ed. New York. 1930.
Maguire, Charles Joseph. Aerology. A ground school manual in aeronautical meteorology. New York. 1931.
National Geographic Society. U. S. army air corps stratosphere flight of 1935 in the balloon "Explorer II." Washington. 1936.
Noth, Hermann. Wetterkunde für Flieger und Freunde der Luftfahrt. 2d ed. Berlin. 1934.

AGRICULTURAL METEOROLOGY

Henry, A. J., & others. Weather and agriculture. Washington, 1925. (U. S. Dept. of agriculture. Separate from yearbook. 1924. No. 918.)
Holdefleiss, Paul. Agrarmeteorologie. Berlin. 1930.
Klein, Paul, & Sanson, Joseph. Météorologie et physique agricoles. Paris. 1925.
Smith, J. Warren. Agricultural meteorology. New York. 1920.

ATMOSPHERIC ELECTRICITY

American Institute of Electrical Engineers. Lightning reference book. New York. 1937.
Chauveau, B. Electricité atmosphérique. 3 volumes. Paris. 1922–25.
Covert, Roy N. Protection of buildings and farm property from lightning. Washington. 2d ed. 1930. (U. S. Dept. of agriculture. Farmers' bull. 1512.)
General Electric Review. Reprints of papers on lightning. Various authors. Schenectady. 1937.
Gockel, Albert. Das Gewitter. 3d ed. Berlin. 1925.
Kähler, Karl. Einführung in die atmosphärische Elektrizität. Berlin. 1929.
Peters, Orville S. Protection of life and property against lightning. Washington. 1915. (U. S. Bureau of standards. Technologic paper 56.)
Schonland, B. F. J. Atmospheric electricity. London. 1932.
Swann, W. F. G. Atmospheric electricity. (In Journal of Franklin institute, Philadelphia, Nov. 1919, pp. 577–606.)
U. S. Bureau of standards. Code for protection against lightning. Washington. 1929.
Voigts, Heinrich. Luftelektrizität. Berlin. 1927.

FROST

Reed, William Gardner. Frost and the growing season. Washington. 1918. (U. S. Dept. of agriculture. Atlas of American agriculture, part 2, sect. 1.)
Young, Floyd D. Frost and the prevention of frost damage. Washington. 1929. (U. S. Dept. of agriculture. Farmers' bull. 1588.)

INSTRUMENTS, INSTRUCTIONS, TABLES

Great Britain, Meteorological office. The computer's handbook. London. 1915–. [In course of publication, in parts.]
Great Britain, Meteorological office. The meteorological observer's handbook. London. 1934.
Kleinschmidt, E., and others. Handbuch der meteorologischen Instrumente und ihrer Auswertung. Berlin. 1935.
Smithsonian institution. Smithsonian meteorological tables. 5th ed. Washington. 1931.
U. S. Weather bureau. Circulars. A. Instructions for obtaining and tabulating records from recording instruments. B. and C., combined, Instructions for coöperative observers. D. Instructions for the installation and maintenance of wind measuring and recording apparatus. E. Measurement of precipitation. F. Barometers and the measurement of atmospheric pressure. G. Care and management of electrical sunshine recorders. I. Instructions for erecting and using weather bureau nephoscope. L. Instructions for the installation and operation of class A evaporation stations. M. Instructions to marine meteorological observers. N. Instructions for airway meteorological service. O. Instructions for making pilot balloon observations. P. Instructions for making aerological observations. Q. Pyrheliometers and pyrheliometric observations. R. Preparation and use of weather maps at sea. Washington. [Various dates.]
U. S. Weather bureau. Psychrometric tables. Washington. 1912.
U. S. Weather bureau. Instructions to storm-warning displaymen. Washington. 1912.
U. S. Weather bureau. Instructions for installation and use of telethermoscopes. Washington. 1937.
U. S. Weather bureau. International code for radio weather reports from ships. Washington. 1931.

MARINE METEOROLOGY

Allingham, William. A manual of marine meteorology. 3d ed. London. 1927.
Great Britain, Meteorological office. Marine observer's handbook. 6th ed. London. 1937.
Great Britain, Meteorological office. A barometer manual for the use of seamen; a text book of marine meteorology. 11th ed. London. 1932.
Great Britain. Meteorological office. A handbook of weather, currents, and ice, for seamen. London. 1935.
Russeltvedt, Nils. Measurement of temperature on board ships. Oslo. 1936. (Geofysiske Publikasjoner Vol. XI. No. 10.)
Smith, L. A. Brooke. Wireless and weather; an aid to navigation. London. 1928. (Great Britain, Meteorological office, M. O. 297.)
Tannehill, I. R. Preparation and use of weather maps at sea. Washington. 1935. (U. S. Weather Bureau. Circular R.)
U. S. Weather bureau. Instructions to marine meteorological observers. 6th ed. Washington. 1938. (Circular M.)
U. S. Weather bureau. Average conditions of wind and weather, North Pacific Ocean. Washington. 1937.

STORMS

Algué, José. Cyclones of the far east. 2d ed. Manila. 1904.
Bowie, Edward H., & Weightman, R. Hanson. Types of storms of the United States and their average movements. Washington. 1914. (U. S. Weather Bureau. Monthly weather review. Supplement 1.)
Cline, Isaac M. Tropical cyclones. New York. 1926.
Fassig, Oliver L. Hurricanes of the West Indies. Washington. 1913. (U. S. Weather Bureau. Bull. X.)
Finley, John P. Tornadoes; what they are and how to observe them. New York. 1887.
Froc, Louis. L'atmosphère en extremê-orient; son état normal, ses perturbations. 2d ed. Paris. 1920. [Full account of typhoons.]
Garriott, E. B. West Indian hurricanes. Washington. 1900. (U. S. Weather bureau. Bull. H.)
Tannehill, Ivan Ray. Hurricanes, their nature and history. Princeton. 1938.
Iyer, V. Doraiswamy. Typhoons and Indian Weather. (Memoirs of the India meteorological department.) Delhi. 1936.
Laughton, L. G. C., & Heddon, V. Great storms. London. 1927.
Mitchell, Charles L. West Indian hurricanes and other tropical cyclones of the North Atlantic ocean. Washington. 1924. (U. S. Weather bureau. Monthly weather review. Supplement 24.) Also supplementary article of same title, Monthly weather review, vol. 60, p. 253, December, 1932.
Newnham, E. V. Hurricanes and tropical revolving storms. London. 1922. (Great Britain, Meteorological office. Geophysical memoirs no. 19.)
Schubart, L. Praktische Orkankunde; mit Anweisungen zum Manövrieren in Stürmen. Berlin. 1934.
Tannehill, I. R. The hurricane. Washington. 1934. (U. S. Dept. of agriculture. Miscellaneous publ. 197.)
Visher, Stephen S. Tropical cyclones of the Pacific. Honolulu. 1925. (Bernice P. Bishop museum. Bull. 20.)
Wegener, Alfred L. Wind- und Wasserhosen in Europa. Braunschweig. 1917.

MISCELLANEOUS

Baur, F. Einführung in die Grosswetterforschung. Berlin. 1937.
Glazebrook, Sir Richard. A dictionary of applied physics. Vol. III. Meteorology. London. 1923.
Great Britain, Meteorological office. Meteorological glossary. 2d ed. London. 1930.
Haurwitz, B. The physical state of the upper atmosphere. Toronto. 1937.
Humphreys, William J. Rain making and other weather vagaries. Baltimore. 1926.
Humphreys, W. J. Weather proverbs and paradoxes. 2d ed. Baltimore. 1934.
Inwards, Richard. Weather lore; a collection of proverbs, sayings, and rules concerning the weather. 3d ed. London. 1898.

Lexique météorologique. Paris, l'office national météorologique. Fasc. 1-VII, 1926-1931.
Middleton, W. E. Knowles. Visibility in meteorology. Toronto. 1935.
Pernter, Joseph M., and Exner, Felix M. Meteorologische Optik. 2d ed. Wien, etc. 1922.
Royal Meteorological Society. Some problems of modern meteorology. London. 1935.
Seligman, G. Snow structure and ski fields, with an appendix on alpine weather. London. 1936.
U. S. Weather bureau. Weather folk-lore and local weather signs. Washington. 1903.

CLIMATOLOGY

Bonacina, L. C. W. Climatic control. 3d ed. London. 1927.
Brooks, C. E. P. Climate. 3d ed. London. 1932.
Brooks, C. E. P. Climate through the ages. London. 1926.
Brooks, C. E. P. The evolution of climate. 2d ed. London. 1925.
Edwards, K. C. The A B C of climate. London. 1930.
Hann, Julius. Handbuch der Klimatologie. Vol. 1. 4th ed. (Revised by Karl Knoch). Stuttgart. 1932.
Note.—[The second edition of this volume has been translated into English, with some additions, by R. DeC. Ward, New York, 1903, but the translation is out of print and rare.]
Kendrew, W. G. Climate. Oxford. 1930.
Köppen, W. Grundriss der Klimakunde. Berlin. 1931.
Köppen, W., and Geiger, R., eds. Handbuch der klimatologie. Vol. 1. Berlin. 1936.
Miller, A. A. Climatology. London. 1931.
Ward, Robert DeCourcy. Climate, considered especially in relation to man. 2d ed. New York. 1918.

Climate and Health

Lampert, H. Heilquellen und heilklima. Dresden and Leipzig. 1934.
Petersen, W. F. The patient and the weather. 3 vols. (in parts). Ann Arbor, Mich. 1934.
Piéry, M., ed. Traité de climatologie biologique et médicale. Paris. 1934. 3 vols.
Weber, F. Parkes, & Hinsdale, Guy. Climatology; health resorts; mineral springs. Philadelphia. 1902. 2 vols. (Cohen, S. S. A system of physiologic therapeutics, vols. 3 and 4.)
Ward, R. DeC. The Climates of the United States. Boston. 1925. (Chapter XXI, Climate and Health.)

CLIMATOGRAPHY

Bartholomew, J. G. Physical Atlas, vol. 3. Meteorology. London. 1899.
Clayton, H. Helm, et. al. World weather records. Records of barometric pressure, temperature, and precipitation for 287 selected stations in different parts of the world. Washington. Smithsonian miscellaneous collections, vol. 79, 1927. Supplement covering same stations for 1921-1930, vol. 90, 1934.
Hann, J. Handbuch der Klimatologie, 3d ed., Stuttgart, 1908-1911. Vol. 2. Torrid zone; vol. 3. Temperate and frigid zones.
Kendrew, W. G. Climates of the continents. 3d ed. Oxford. 1937.
Köppen, W., and Geiger, R., eds. Handbuch der klimatologie. Vol. 2. America, vol. 3. Europe and Northern Asia, vol. 4. Southern Asia and Australia, vol. 5. Africa, Oceans. (In course of publication, in parts.)

Climate of the United States

Henry, A. J. Climatology of the United States. Washington. U. S. Weather Bureau Bulletin Q. 1906.
U. S. Department of Agriculture. Atlas of American agriculture. Washington. 1936.
U. S. Weather Bureau Bulletin W. Summaries of climatological data by sections. Washington. 1st ed. 2 vols. 1912. 2d ed. (revised). 3 vols. 1926. A third edition (revised) is nearly complete.
Ward, R. DeC. The climates of the United States. Boston. 1925.

LEADING METEOROLOGICAL JOURNALS

Periodicals

Annalen der Hydrographie und maritimen Meteorologie. Berlin, etc. 1873–.
Beiträge zur Physik der freien Atmosphäre. Strassburg. 1904–.
Bulletin of the American meteorological society. Milton, Mass. 1920–.
Marine observer. London. 1924–. [Published by Meteorological office.]
Meteorological magazine. London. 1866–. [Published by Meteorological office.]
Météorologie. Paris. 1925–. [Published by Société météorologique de France.]
Meteorologische Zeitschrift. Braunschweig, etc. 1884–.
Monthly weather review. Washington. 1872–. [Published by U. S. Weather bureau.]
Quarterly journal of the Royal meteorological society. London. 1871–.
Zeitschrift für angewandte Meteorologie. Berlin. 1885–.

Serials

Det Norske Meteorologiske Institutt. Geofysiske Publikasjoner. Oslo. 1920.
Det Norske Videnskaps—Akademi. Astrophysica Norvegica. Oslo. 1935–.
Deutsche Seewarte. Aus dem Archiv der Deutschen Seewarte. Hamburg. 1878–.
Deutsches Reich. Reichsamt für Wetterdienst. Wissenschaftliche Abhandlungen. Berlin. 1935–.
Great Britain. Meterological office. Geophysical memoirs. London. 1911–. Professional notes. London. 1918–.
India meteorological department. Scientific notes. Delhi. 1926–. Memoirs. Delhi. 1876–.
Massachusetts Institute of Technology. Papers in physical oceanography and meteorology. Boston. 1930–.
Memoirs of the Royal Meteorological Society. London. 1926–.
Sweden. Statens meteorologisk—hydrografiska anstalt. Meddelanden. Stockholm. 1920–.
Veröffentlichungen des geophysikalischen instituts der universität Leipzig. 1913–.
Veröffentlichungen des meteorologischen instituts der universität Berlin. 1936–.

METEOROLOGY IN RELATION TO STREAM FLOW

Works recommended for Weather Bureau river district centers

Hazen, A. Flood flows. New York. 1930.
Houk, I. E. Rainfall and run-off in the Miami Valley. Dayton. 1921.
Mead, D. W. Hydrology. New York. 1919.
Meyer, A. F. Elements of hydrology. New York. 1917.
Miami Conservancy District. Storm rainfall of eastern United States. 2d ed. Dayton. 1936.
Newell, F. H. Water resources, present and future uses. New Haven. 1920.
Schaffernak, F. Hydrographie. Vienna. 1935.
Thomas, H. A. The Hydraulics of flood movements in rivers. Pittsburgh. 1937.

UPPER WIND FORECASTING

By B. C. HAYNES

[Boeing School of Aeronautics, Oakland, Calif., June 1937]

INTRODUCTION

The problem of determining the direction and velocity of the wind in the upper levels of the atmosphere is becoming increasingly important with the development of long-range flying equipment. In long flights the upper wind distribution is one of the prime considerations in determining the balance between pay load and fuel. Companies operating over distances of 1,500 miles or more use the upper wind data to estimate the amount of gasoline to be carried. An increase in the number of airway traffic control stations also makes necessary accurate upper wind information for estimations of flight time from station to station.

The problem then is to select a satisfactory method of representing the upper wind field so that the meteorologist may visualize the changes which might occur and to estimate these changes as accurately as possible.

In the United States upper wind observations are made mostly by single theodolite observations of free balloons. This method of observation assumes a constant rate of ascent of the balloon and the velocity is given by taking the resultant of the horizontal components of the average velocities for each two successive 600-foot levels. The meteorologist at present smooths his surface pressure map which is made up of very exact readings of mercurial barometers. The smoothing process damps out small local variations and should be used on weather maps representing any meteorological element. The most natural method seems to be to draw stream lines of the air flow.

COMPUTATION OF A GEOSTROPHIC WIND SCALE

Since the magnitude of wind velocity is proportional to the pressure gradient, a scale may be constructed which will give the correct spacing of the stream lines and the upper wind maps will be comparable to the surface pressure maps; the actual value of the pressure is immaterial. The pressure gradient, however, depends upon two components, the geostrophic component and the cyclostrophic component. This is shown in the following equation:[1]

$$\frac{1}{D}\frac{dP}{dN}=2\omega V\sin L\pm\frac{V^2}{r}$$

where D is the density of the air, $\frac{dP}{dN}$ the pressure gradient, ω the angular velocity of the earth, V the wind velocity, L the latitude, and r the radius of curvature of the trajectory.

The geostrophic component $2\omega V\sin L$ depends upon the latitude and the cyclostrophic component $\frac{V^2}{r}$ upon the radius of curvature of the trajectory. In the upper wind systems over the United States, especially above 5,000 feet, the cyclostrophic component becomes small in comparison to the geostrophic component.

Neglecting the term $\frac{V^2}{r}$ the equation becomes:

$$\frac{1}{D}\frac{dP}{dN}=2\omega V\sin L$$

[1] D. Brunt, Physical and Dynamical Meteorology, p. 183.

Assuming an average latitude of 40° N. and writing $\frac{dP}{dN}$ as the change of pressure of 0.10 inches of Hg per "x" miles the equation will reduce to:

$$x=\frac{314.57}{DV}$$

where x is the distance between 0.10 in. of Hg isobars or stream lines, D is the air density at any given level in pounds per cubic foot as computed for the standard atmosphere, and V the wind velocity in miles per hour.

Table 1 gives the results of computations for six levels: sea level, 5,000 feet, 8,000 feet, 10,000 feet, 12,000 feet, and 14,000 feet. These may be laid out along the sides of a hexagon on a scale corresponding to that of the map

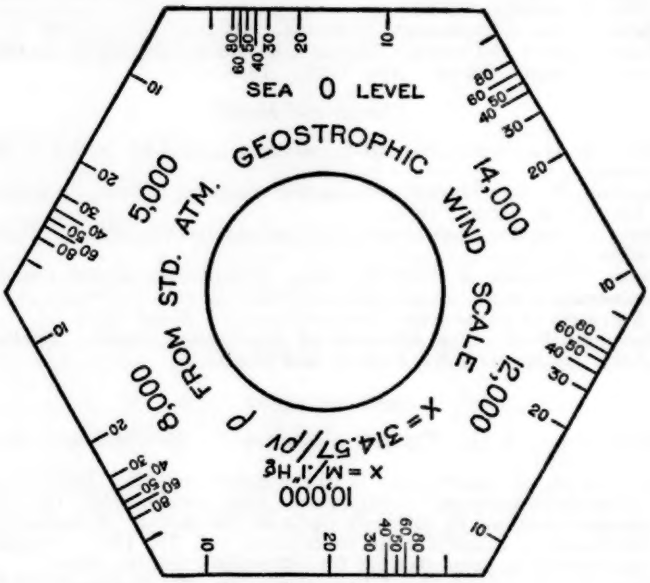


FIGURE 1.—Geostrophic wind scale.

which is being used. Figure 1 shows a scale which was constructed for use on the upper wind charts used by the Weather Bureau.

TABLE 1.—*Geostrophic wind values*

[Distances in miles between 0.10 in. Hg isobars for various wind velocities at different levels]

Level, feet above sea level	Air density, lbs./cu. ft.[1]	Wind velocity in miles per hour						
		10	20	30	40	50	60	80
0	0.0765	411	206	137	103	82	69	51
5,000	.0659	477	239	159	119	96	80	59
8,000	.0601	523	262	175	131	105	87	65
10,000	.0565	557	278	186	139	111	93	70
12,000	.0530	594	297	198	148	118	99	74
14,000	.0497	633	317	211	159	127	106	80

[1] W. R. Gregg, Aeronautical Meteorology, p. 78.

For standard atmosphere at 40° N. latitude, sea level pressure=29.921 in. Hg., temperature=59° F., temperature lapse rate=3.566° F. per 1,000 feet.

CONSTRUCTION OF AN UPPER WIND CHART

Returning now to the problem of determining the structure of the upper wind systems, the problem of forecasting

any meteorological element depends mainly on a correct analysis of the latest synoptic condition and a thorough understanding of the history of its development. The actual forecast is merely an extrapolation tempered by physical and meteorological considerations.

The geostrophic wind scale gives a quick method for constructing an upper wind map which will have a physical

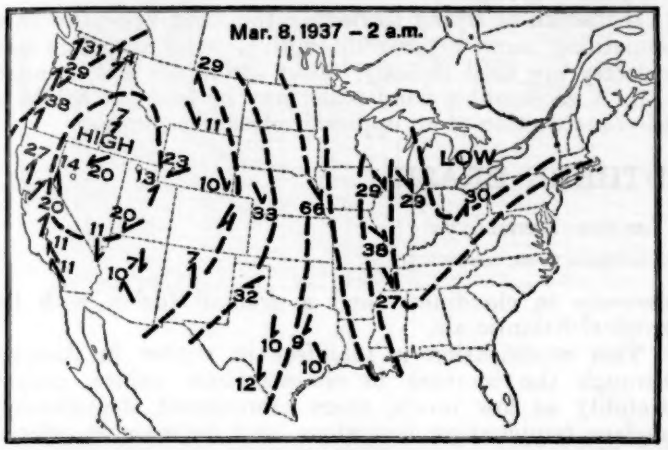


FIGURE 2.—Upper wind map for the 8,000-feet level, 2 a. m. Pacific standard time March 8, 1937.

meaning. With the aid of several consecutive wind charts, say at 12-hour intervals for the desired levels, the meteorologist can see the historical development and obtain a picture which will enable him to visualize the changes which are taking place.

The procedure followed in the construction of an upper wind chart is:

1. Sketch in lightly the approximate streamlines (lines tangent to the instantaneous velocity arrows on the

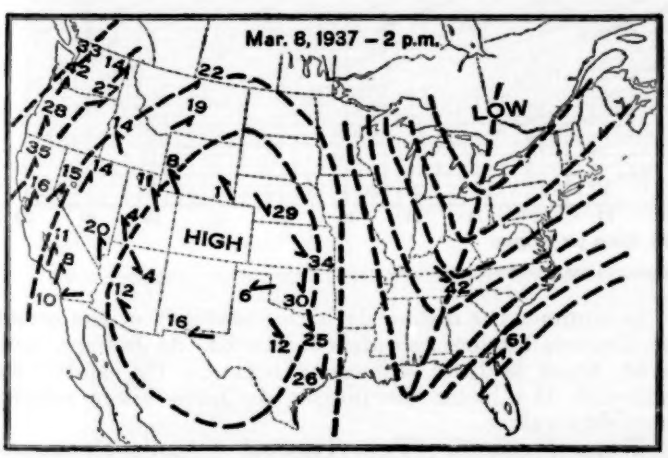


FIGURE 3.—Upper wind map for the 8,000-feet level, 2 p. m. Pacific standard time, March 8, 1937.

wind chart). In some cases the arrow will deviate from the majority of the arrows and the smoothing process is to make an estimate of the average direction of flow. (Only maps for levels 2,000 feet above the surface of the earth or higher should be drawn with streamlines.)

2. The second step is to pick out one streamline which seems to follow smoothly through the field with uniform or uniformly increasing or decreasing wind velocities. This line will be a base from which the rest of the field may be constructed.

3. Neglecting all of the original streamlines except the one chosen as a base, the rest of the field may be constructed by using the average wind velocities in the given area together with the geostrophic wind scale to determine the distance at which the next streamline will be placed. Working from each successive streamline in this manner, a wind field which is similar in appearance to a pressure field will finally be obtained.

Since the streamlines are at distances which are proportional to 0.10 in. of Hg pressure, one can refer to the streamlines as isobars and call the anticyclonic circulations high pressure areas, and the cyclonic circulations low pressure areas.

Figures 2, 3, and 4 show three such fields on three successive upper wind charts for the 8,000-foot level. Figure 2 shows a large anticyclonic circulation over the Great Basin. Figure 3, 12 hours later, shows that the center has moved into New Mexico, and figure 4 shows the same center over Texas.

FORECASTING PROCEDURE

The trajectory of the center is noted from map to map and an extrapolation is made for any given time in the

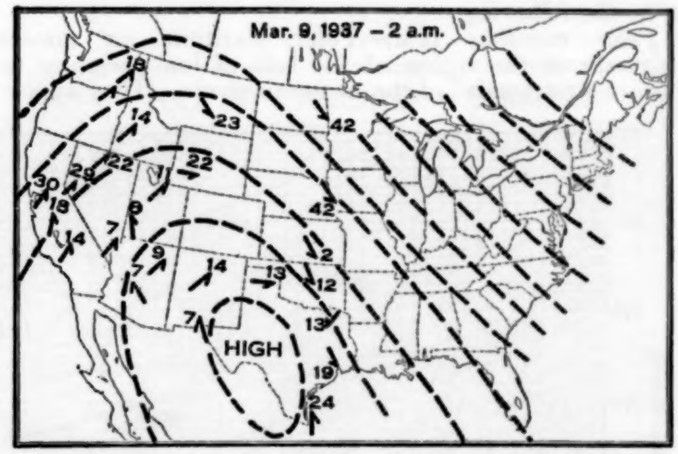


FIGURE 4.—Upper wind map for the 8,000-feet level, 2 a. m. Pacific standard time, March 9, 1937.

future. Fronts or wind shift lines are noted. They are frequently extensions of surface fronts and can be plotted accurately from consideration of the surface chart. Considerable attention should be given to noting changes of gradients in the moving systems to determine the areas of increasing or decreasing wind velocities. Since the wind direction is that of the tangent to the streamline changes in direction may easily be anticipated. With a small amount of practice the meteorologist will be able to visualize upper wind changes and give wind forecasts which are based on a thorough knowledge of the synoptic situation.

Such a series of maps not only enables the meteorologist to forecast accurately the wind distribution at any desired time but also to fill in missing wind reports. Occasionally large areas become overcast with low cloud systems and no observations can be made for long periods of time. If the streamline systems are carefully carried along from day to day even with only a few scattered reports, it is possible to give intelligent estimates of upper wind conditions for periods of from 24 to 48 hours.

Upper wind forecasts, which have been made for regular air line operation using these methods, have shown an extremely high degree of accuracy with only a few cases with deviations of more than 1 point in direction on an 8-point compass and 5 miles per hour in velocity.

At present only a few Weather Bureau stations use streamlines on the upper wind maps. The streamlines

as used are only indications of direction and give no estimate of velocity.

From the standpoint of air line operation in the future with airplanes built to fly through heavy weather, operation will depend only upon two things, terminal conditions and the upper wind distribution.

It is hoped that by using a wind scale such as here described, upper wind forecasting will be put on more of a uniform basis.

CONCLUSIONS

1. Upper wind charts using streamlines which are tangent to the wind arrows and spaced according to the velocity give a clearer picture of the wind conditions aloft than charts using only wind arrows.

2. The isobars on the present weather map are used because they indicate the direction and velocity of the wind. Unless the meteorologist considers the change in pressure for rapidly moving pressure systems the winds computed from the isobars give only the conditions for a stationary system.

If instead of trying to deduce the wind velocities from something more or less intangible, wind direction and velocity are used directly, fewer errors are apt to arise.

3. A geostrophic wind scale may be laid out to aid in the construction of an upper-air streamline map.

AIR MASSES OF SOUTHERN BRAZIL

By ADALBERTO SERRA and LEANDRO RATISBONNA

[Departmento de Aeronáutica Civil, Rio de Janeiro, Brazil, October 1937]

From preliminary studies made on the atmospheric circulation of South America, the principal air masses that pass over Rio de Janeiro and Alegrete have been found to be the following:

Polar maritime (PM)—Polar maritime air masses originate in the region of the belt of low pressures or "brave west winds" of the Antarctic circle. They appear south of Brazil as anticyclones, which upon coming in contact with the tropical air masses form cold fronts along which storms develop.

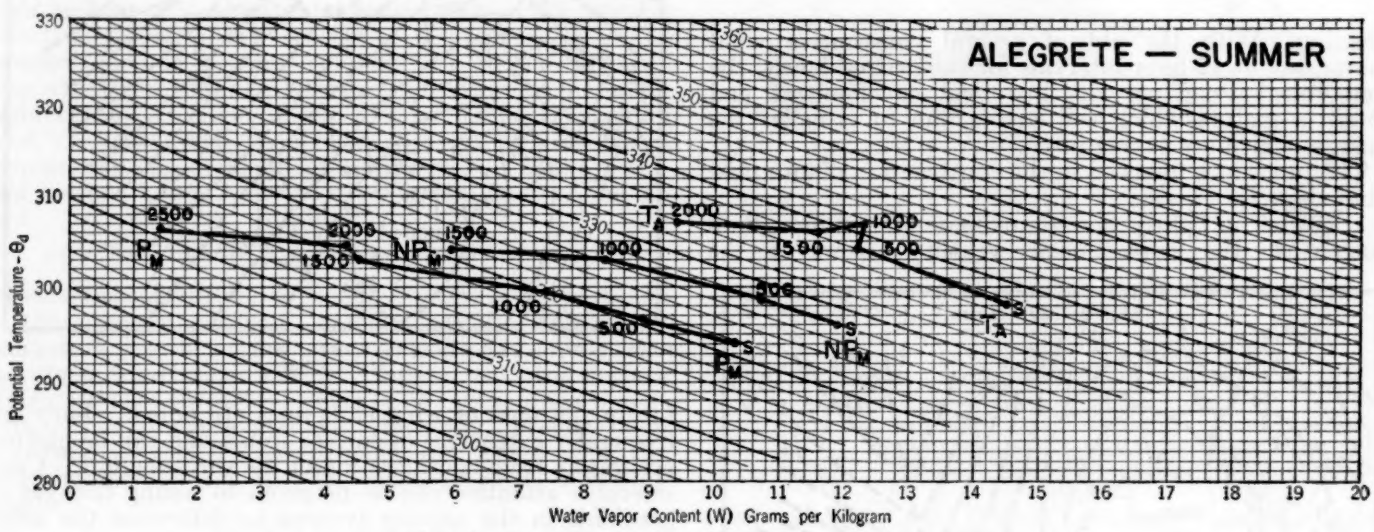


FIGURE 1.—Characteristic curves of air masses at Alegrete during summer.

In winter, in Alegrete, these masses are convectively unstable. They have low values of temperature and relative humidity because they are moving over regions which are warm relative to the source. These air masses frequently reach Rio de Janeiro but due to the accompanying bad weather, soundings are not practicable.

In summer, despite an increase in values of w and θ_E, the winter characteristics persist at Alegrete. In Rio de Janeiro, however, the relative humidity is at a maximum, as a result of abundant rainfall at cold front passages; the other characteristics remain unchanged.

The pronounced increase in the characteristic values at Rio de Janeiro over those observed at Alegrete should be noted. In general, stratification is not very marked, but rather a tendency to homogeneity is evident.

Modified polar maritime (NPM)—In proceeding to lower latitudes, the polar air decreases in velocity, and a modification takes place which is characterized by subsidence, decrease in cloudiness, and a gradual fusion with the tropical Atlantic air.

This modification is manifest in winter in Alegrete through the increase in characteristic values, greater stability at low levels, more pronounced stratification, surface temperature inversions, and decrease in relative humidity.

In summer the ordinarily high instability of the season at Alegrete hinders subsidence. In Rio de Janeiro, however, there is little difference between PM and NPM, although the latter air masses do have lower relative humidity values.

Tropical Atlantic (TA)—Tropical Atlantic air masses originate in the center of action of the south Atlantic and are transported by NE, N, and NW winds.

In winter these masses prevail at Rio de Janeiro (situated near the source region), almost exclusively. They show great instability at the surface, due to local heating, and small lapse rates. On account of their maritime origin they have high relative humidities.

These masses reach Alegrete after a long trajectory, and a gradual cooling can be noticed in the lower levels with a consequent increase in stability indicated by a surface inversion. Relative humidity remains high as a result of the lower temperature.

In summer, in Rio de Janeiro, stratification and instability are both pronounced, but the relative humidity, although high throughout the lower levels, decreases with

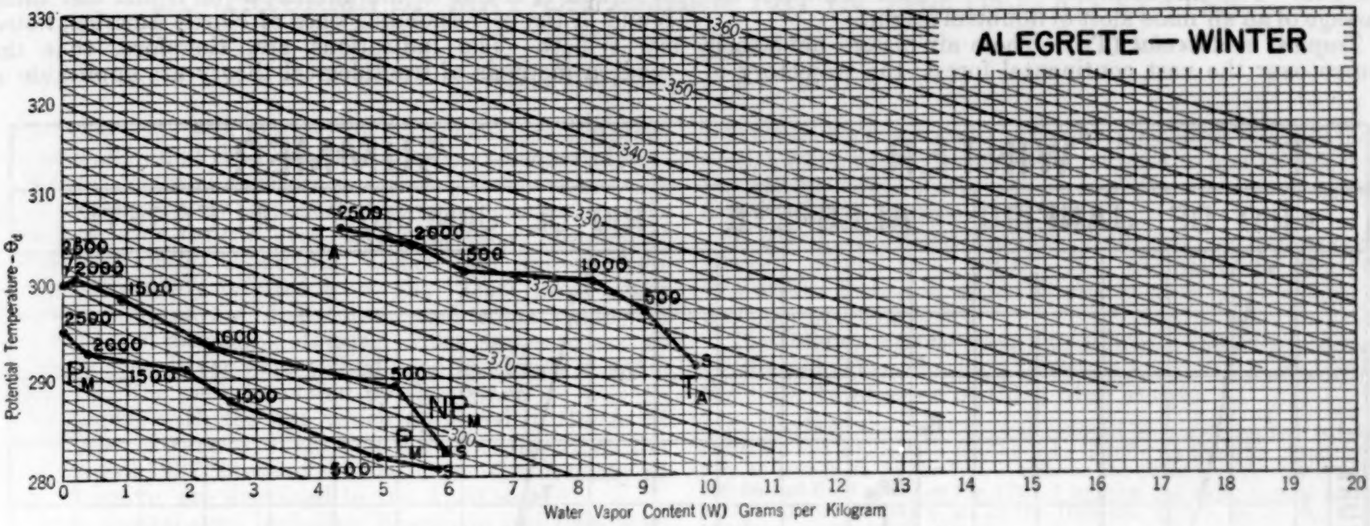


FIGURE 2.—Characteristic curves of air masses at Alegrete during winter.

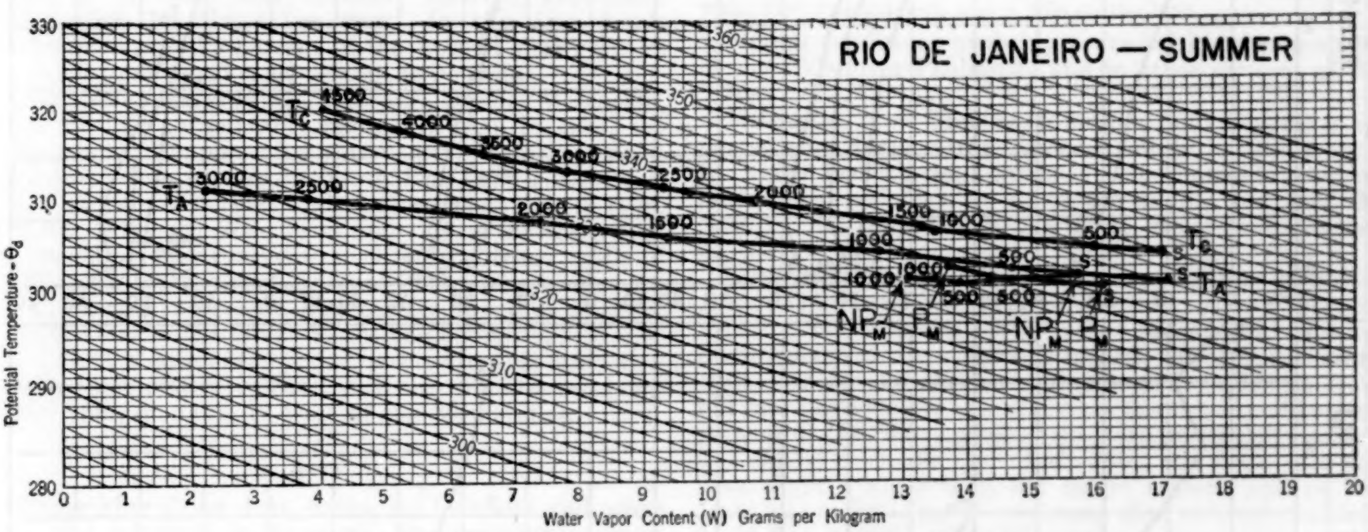


FIGURE 3.—Characteristic curves of air masses at Rio de Janeiro during summer.

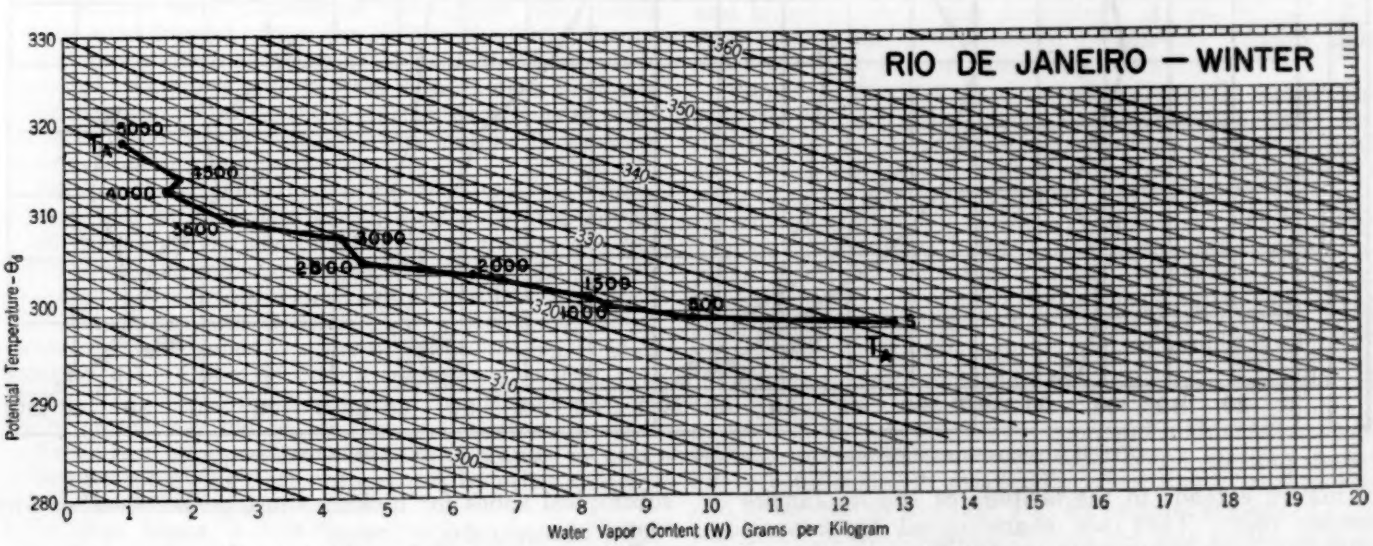


FIGURE 4.—Characteristic curves of tropical Atlantic air masses at Rio de Janeiro during winter.

altitude. The discontinuity at 1,000 meters implies the passage of an air mass aloft of doubtful origin.

Tropical continental (Tc)—These air masses have their source over the vast continental forest; the trajectory of Tc masses extends to the latitude of Rio de Janeiro in summer only. They are characterized by convective instability, high temperature, and high relative humidity.

In the accompanying tables and charts, attention is directed to the great similarity existing between the values of w and θ_E found in the air masses of Brazil and those found in the corresponding ones of North America, noted by Willett. The indications are, therefore, that the modern methods of frontological theory are applicable in subtropical zones for making short period weather forecasts.

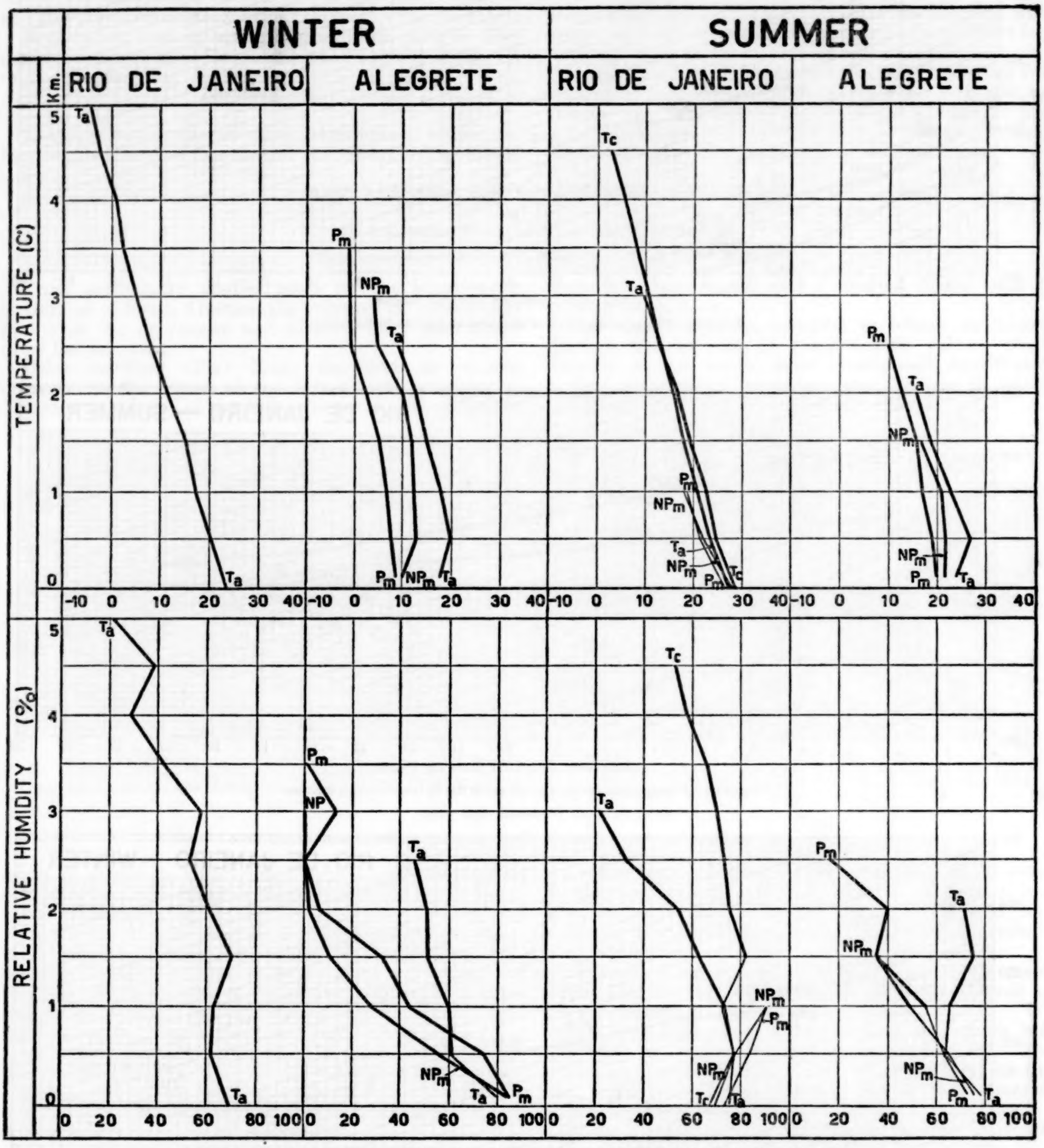


FIGURE 5.—Upper-air temperature and humidity values for winter and summer at Rio de Janeiro and Alegrete.

Future notes will be added to the present data, as soon as more details of South American air masses are available.

DUSTSTORMS OF MAY-DECEMBER 1937 IN THE UNITED STATES

By R. J. MARTIN

[Weather Bureau, Washington, D. C., January 1938]

The year 1937 was marked by subnormal precipitation in practically all of the Great Plains area and some adjoining States. Subsoil moisture was greatly deficient and dry surface soil was easily transported by even light winds. As a result a large central area, including those portions of Colorado, Kansas, Oklahoma, Texas, and eastern New Mexico, commonly referred to as the "Dust Bowl", had numerous and severe duststorms, and some States to northward had damaging storms. Most States to east of the Mississippi River were visited by dust clouds at some time during the period covered by this paper.

This paper, with the one which appeared in the April issue of the MONTHLY WEATHER REVIEW, describes the duststorms of 1937; those of the first 4 months, January to April, inclusive, are discussed in the April issue.

A large central area, including Wisconsin and Illinois to east of the Mississippi River, and Iowa, Missouri, Montana, the Dakotas, Nebraska, Kansas, Oklahoma, Texas, Colorado, Nevada, and Arizona, received subnormal precipitation for the entire year. In this area totals ranged from only 75 percent of the normal yearly fall in Nebraska to as much as 99 percent in Nevada.

Most Great Plains States, Missouri, Illinois, Wisconsin, and Iowa had considerably more rain than in 1936, the increases over the preceding year varying from 10 percent in Kansas to 48 percent in North Dakota. Texas, with only 87 percent of normal, had 13 percent less than in 1936. In Iowa, Missouri, Wisconsin, and Illinois increases over the preceding year ranged from 5 to 20 percent, while of the Western States listed Arizona, Colorado, and Nevada had 9, 10, and 11 percent, respectively, less than in 1936.

Large areas in the Great Plains had subnormal precipitation every month of the period covered by this summary; May was the relatively driest, with only 6 States receiving normal rain, or more, to west of the 80 meridian.

MAY

During May dense dust, damaging to wheat and other crops and injurious to livestock, was reported in most States from northwestern Texas and New Mexico northward. Storms were distributed throughout the month but were most frequent from the 18th to the 28th. Severe dust was reported on as many as 21 days of the month in portions of Oklahoma and on from 4 to 15 days in southwestern Kansas. During these storms, as well as in some of those in other States, visibility was materially reduced, dangerously so in many instances.

At Malta, Mont., the storm of the 28th was the "worst ever seen—for an hour and a half dust blew at a terrific rate, so thick that the greater part of the time it was impossible to see the radiator cap on a car (from the driver's seat)—dust sifted into the closed cars until it was an inch thick. When the rain came it blew into the car doors until the dirt was mud." (Havre, Mont., Journal, May 30, 1937.) The Chinook, Mont., Opinion classified this storm as "the worst ever seen here." At Helena air and highway traffic was halted, and, in the northern part of the State, cars stopped on highways, because of poor visibility from blowing dust, were struck by other vehicles and some personal injuries resulted.

At Billings, Mont., a dust "layer" which persisted from the evening of the 23d to the early morning of the 25th was found by aviators to have an upper limit of 4,430 feet; on the 28th, when visibility was reduced to one-eighth mile for half an hour, the upper limit of the cloud was 10,000 feet above the surface.

Western and northwestern Texas had several severe storms. At El Paso, on the 22d, the visibility was 700 feet or less from 6 a. m. until nearly noon; at 7 o'clock it was only 300 feet.

The following paragraph, taken from a report submitted by the official in charge, Oklahoma City, Okla., describes the severity of some of these May storms:

> At Goodwell the visibility was reduced to ½ mile on the 1st, 150 yards on the 3d, ½ mile on the 4th, ¼ mile on the 6th, practically zero at 7:45 p. m. on the 7th, ½ mile on the 10th, ¼ mile on the 11th, 100 feet at 6:30 p. m. on the 12th, 1 mile on the 14th, ¼ mile on the 15th, 100 feet at 5:45 p. m. of the 16th and at 6 p. m. on the 17th, 150 feet on the 19th at 6 p. m., ¼ mile on the 20th, zero on the 21st from 7:09 p. m. to 11:09 p. m., ¼ mile on the 23d, 100 feet at 8:45 a. m. on the 24th, ½ mile on the 25th, 1 mile on the 26th, only 10 feet for a short time at 3:45 p. m., with some rain falling while dust was heaviest, and ½ mile on the 30th.

Similar conditions probably prevailed in other portions of the Oklahoma Panhandle and in other sections of the "Dust Bowl."

Nebraska, New Mexico, Montana, and Wyoming reported crop damage from blowing soil during the month. In North Dakota the Dickinson Experiment Station reported that soil blowing about the middle and near the close of the month was the most severe ever experienced.

The unusually numerous and severe storms in northeastern Montana were the worst ever known in that region; grain seed was blown out of the soil and growing grain cut off at the surface or buried. In Teton County grain was cut off three times this spring. Losses from soil blowing were general in the north-central and eastern portion of the State; duststorms were particularly severe and extensive on the 11th, 12th, 18th, and 28th. On the 28th slightly more than the entire eastern half of the State was visited by a severe storm that reduced visibility to 50 feet in from 10 to 30 minutes. Great damage resulted to seeded and growing grain and range grass. Air and highway traffic was disrupted. At the Billings Airport Station the wind attained an extreme velocity of 76 miles per hour and at Miles City, 68 miles.

Numerous duststorms occurred in Colorado and on the 21st the visibility was reduced to from one-quarter to one-half mile in most southeastern counties and was rendered zero in extreme southeastern counties where conditions were reported as "dark as night" and "absolutely black." In some sections the storm was the worst of the year. The swirling clouds of dust halted traffic, interrupted airplane schedules and made living conditions extremely uncomfortable. On the 28th the entire region east of the 103d meridian was covered by a dust pall which reduced visibility to from 20 to 200 feet for from 4 to 7 hours.

Light dust was much more extensive and was reported throughout the Great Plains, much of the Rocky Mountain district, in most of the Lake region and middle Mississippi Valley, and locally to eastward. Some stations noted dusty conditions on practically every day of the month and as far east as Reading, Pa., an unusual amount of dust was noted in the atmosphere from the 25th to the close of the month.

JUNE

During June the Great Plains States from Nebraska southward, Iowa, Minnesota, Wisconsin, Utah, and Nevada were among the 14 States receiving subnormal rainfall. Amounts ranged from only 47 percent of normal in Nevada to as much as 95 percent in Oklahoma.

Despite this increase of precipitation over the preceding month, duststorms were again rather severe and numerous though less so than in May. Dense duststorms were reported from Texas and New Mexico northward to Montana with frequency ranging from one occurrence to as many as 12 storms during the month.

Probably the most severe and extensive duststorm ever experienced in the history of Montana occurred on June 2–3. Dense clouds of dust overspread the State from the Rocky Mountain Divide eastward to the Dakotas and from the Canadian border southward to Wyoming, but only three stations west of the Divide, Kalispell, Philipsburg, and Butte, reported dense dust during this storm. The dust apparently moved into Montana from Canada shortly before midnight of the second and was carried by strong northwest winds aloft as there were no unusually high winds along the surface while the storm crossed the State. It struck Havre at 11:40 p. m. of the 2d, Helena about 2 a. m. of the 3d, and was at Ekalaka about noon of the 3d. The storm was followed by rains in most of the State, and the cloud had disappeared generally by the night of the 3d. During the densest part of the storm all localities reported visibilities ranging generally from 1 mile to several blocks. In some portions of the State automobile lights were necessary while driving during the day.

June rainfall in the principal duststorm region of Colorado (the extreme southeastern counties) varied from a trace to nearly 4 inches during the month.

In the region (in Colorado) east of the 104th meridian and south of the Arkansas-Platte Divide, dust occurred generally on the 4th, 11th, 12th, 13th, 17th, 18th, 19th, 20th, 22d, 23d, 24th, and 25th. The storm of the 11th–12th was the worst of the month, the visibility being reduced to from zero to 1 mile. On these two dates the storm extended northward to include Kit Carson, Yuma, and northern Lincoln Counties.

Duststorms occurred over much of the western third of Kansas on from 2 to 5 days, and were most frequent in the extreme southwestern part of the State; in Morton County they were reported on the 4th, 6th, 12th, 19th, 20th, 22th, 23th, 24th, and 26th. As a rule these storms were not as widespread as in the 3 months preceding; the one of greatest extent occurred on the 17th. None was reported in the central or eastern thirds of the State.

In Oklahoma, except for one instance on the 26th, duststorms were confined to the Panhandle, where a visibility of 150 feet prevailed at Goodwell for 20 minutes on the 1st. Duststorms were reported on as many as 12 days in portions of this area. A remarkable feature of the dense duststorms of the month in portions of western Kansas is that they occurred comparatively soon after rains that, in some instances, exceeded 3 inches. At Rock Springs, Wyo., during a dust squall on the 23d, the visibility was zero for a few moments with accompanying gusts of wind up to 70 miles per hour.

Light duststorms were nearly as widespread as in May, and were reported from the Rocky Mountains eastward to the Ohio Valley and Tennessee and even as far east as Reading, Pa., where considerable dust was suspended in the air during most of the month. Frequencies ranged from as many as 17 days with light to moderate dust in portions of the northern Great Plains to isolated occurrences in some portions of Texas, the middle Mississippi Valley, and most eastern districts. South of the fortieth parallel they were most frequent during the first half of the month while farther north they were more frequent during the latter half. On the 22d–24th light duststorms were reported in Montana, Wyoming, the Dakotas, Nebraska Iowa, and Minnesota.

JULY

Utah had 211 percent of the normal precipitation during July compared with only 72 percent in June, while Nevada had 189 percent in contrast with 47 for the preceding month. Percentages were also decidedly greater in Montana, the Dakotas, Idaho, and Wyoming than in June, while Kansas noted an increase of 16 percent over the preceding month. As a consequence duststorms were considerably less severe and more restricted in extent in these States than at any time during the preceding several months.

Dense dust occurred on 10 days in portions of Oklahoma, chiefly in the Panhandle area, where occasional zero visibility prevailed temporarily (the July rainfall in Oklahoma was 68 percent of normal, while in June it was 95), and was reported on one day in southeastern New Mexico. In Montana there were brief periods of decidedly limited visibility, ranging from one-half block to less than 1 mile, on 3 or 4 days. Elsewhere duststorms were light to moderate in character and were reported only in the Great Plains from central Texas and southeastern New Mexico northward, in portions of west-central and western Minnesota where, at Moorhead, some damage to crops occurred, and in a few central and northern Rocky Mountain districts, practically all to the east of the Divide.

The frequency of days with duststorms varied from 1 in portions of Texas, New Mexico, Minnesota, and Nebraska to 2 in Wyoming, 3 in North Dakota, 7 in South Dakota, 9 in Kansas, 10 in southeastern Colorado, 15 in Montana, and 17 in Oklahoma; nearly all of those in Oklahoma occurred in the extreme western portion of the State. None was reported east of the Mississippi River.

The storms in North Dakota were rather general on the 5th and 24th; in South Dakota they were most frequent during the first half of the month. Kansas noted dust of limited extent in southwestern counties, chiefly during the first half of the month, but no general duststorms occurred even in those sections where moisture conditions have been most serious.

In contrast to months just preceding, the most severe duststorm of July in Montana, which affected a large area, taking in the southeastern portion of the State from Yellowstone County eastward to the Dakota line and from Prairie County on the north southward to the Wyoming line on the 22d, only reduced visibility to 2½ miles when the storm was at its height.

During the dense duststorm at Roswell, N. Mex., on the 20th, poor visibility began shortly after 1 a. m., and ended at 1:41 a. m. when rain began falling; the minimum visibility, at 1:12 a. m., was only 70 yards.

AUGUST

August brought decidedly subnormal precipitation to all States from the Great Plains westward, except Oklahoma, Washington, and Oregon. Percentages of normal for the month in this area ranged from 10 in California to 88 in Texas. The above-normal precipitation over the northern Great Plains and northern Rocky Mountain region and portions of the Great Basin during July aided

in reducing dust blowing and as a result dense duststorms were rare during August, though isolated occurrences were reported occasionally during the latter half of the month and thick dust somewhat more often from Wyoming eastward to eastern South Dakota and southward to Oklahoma.

Light dust was reported to eastward of the Mississippi River in only one State, Wisconsin, while to west of the Mississippi River, in the Great Plains, duststorms occurred from Oklahoma northward to the Canadian border. The frequency ranged from 5 days or less to as many as 11 in Montana and 12 in Kansas.

In Oklahoma heavy duststorms were of local character and were confined to the central and western sections of the State; Hennessey and Kingfisher, in the central part of the State, reported heavy dust on the 19th with minimum visibility at the latter station being one-fourth mile, while at Goodwell, in the western third, visibility was 50 yards for half an hour on the 4th, one-half mile on the 19th, and 1 mile on the 28th. At Goodwell dusty conditions were noted on 10 days.

Light dust clouds were reported in Baca County, Colo., on several days. During the afternoon of the 9th duststorms of short duration reduced the visibility to 50 yards at Arriba. Though dusty conditions were reported locally on numerous dates throughout the month, they were not attended by serious damage or discomfort.

In South Dakota unseasonably high winds, accompanied by high temperatures, occurred in the eastern two-thirds on the 1st, 5th–9th, 13th–15th, 22d–24th, 27th, and 28th. Local duststorms were reported during these periods where the topsoil was dry.

Duststorms occurred on 1 or 2 days in the western third of Kansas and locally in the middle third, with from 5 to 13 days when there was more or less dust in the air in southwestern counties and 2 to 6 such days in the northwestern counties. Dates given in various counties were August 2, 4, 6, 10, 11, 13–15, 17, 26, 28, and 29; the storms of the 10th and 28th were the most extensive.

SEPTEMBER

Over most of the Great Plains area September brought more rain than the previous month, though only Montana and Oklahoma had above-normal falls. In Montana the September percent of normal was 111 as compared with 49 in August; North Dakota had 96 percent in September and only 71 in August, while Colorado and Wyoming had 90 and 68 percent as compared with 72 and 50 percent during the previous month. September precipitation was also more plentiful over the Southwest, but to east of the Mississippi the month was noticeably drier than August.

Dense dust was confined to portions of the northern and southern Great Plains area. Infrequent occurrences were reported locally in Montana and western Oklahoma, mostly during the latter half of the month; elsewhere dust was only light to moderate. Dusty conditions were reported from central Texas and southern New Mexico northward to Montana, the Dakotas, and Minnesota.

In Montana light dust was reported on 11 days, the 2d, 3d, 4th, 8th, 10th, 13th, 14th, 17th, 18th, 19th, and 21st, while further east and south practically all the duststorms occurred later in the month. In Minnesota they were noted on the 14th, 20th, 21st, and 23d, while in Kansas dusty conditions were noted on the 21st, 23d, 24th, and 27th–30th. Dusty conditions were reported in Oklahoma on 7 days during the month.

Moderate duststorms were reported on 2 days at a considerable number of stations in Nebraska; on the 21st light to moderate dust was reported in south-central counties northward to Valley and Nance Counties. On the 23d dust was again reported in this same area and northward into the northeastern counties and westward into some northwestern areas. On the 23d the dust was dense enough to obscure the sun and cause the day to be reported as cloudy.

On the 14th and 21st light dust was reported at scattered places in western and central North Dakota and on the 23d in south-central sections.

At Kenton and Goodwell, Okla., heavy dust reduced visibility considerably on the 13th and 24th–25th but no damage was reported, while at Helena, Mont., on the 17th, there were limited periods of visibility of less than one half city block.

OCTOBER

During October practically all of the Great Plains, with the exception of Texas, received subnormal precipitation; percentages ranged from 36 in South Dakota to 97 in Nebraska. Utah and Oregon were above-normal for the month, as were Texas, Arkansas, Louisiana, and all States to the east of the Mississippi River, except Michigan.

No dense duststorms were reported, although there were several occurrences of heavy dust in portions of Texas, Oklahoma, and North Dakota. Light dust was reported in Montana, Minnesota, the Dakotas, eastern Colorado, Kansas, Oklahoma, and Texas.

At Amarillo, Tex., a visibility of one-half mile prevailed for 2 hours on the 18th; the highest wind velocity during the storm was 54 miles per hour. Heavy dust in Oklahoma was confined to portions of the Panhandle, mostly on the 1st, 4th, 12th, and 18th. At Goodwell the visibility was less than one-half mile from about 11 a. m. to 4 p. m. on the 18th; the minimum visibility was 100 yards at 11:30 a. m. A few local duststorms were reported in some southwestern counties of Kansas on the 1st, 12th, and 18th; dusty conditions, not sufficiently severe to be classed as duststorms, were noted in many southwestern counties of the State on the 3d, 4th, 6th, 12th, and 18th.

In Colorado light dust and hazy conditions were reported from Julesburg and Cheyenne Wells on the 3d and 4th, from extreme eastern Baca County on the 2d, 4th, 8th, 15th, and 18th, and from extreme eastern Prowers and extreme southern Lincoln Counties on the 18th, on which date the visibility was reduced to 1 mile. The dust on the 8th in the vicinity of Two Buttes, Colo., was somewhat damaging to fields. Light duststorms were general over North Dakota on the 18th and 31st, and an automobile collision occurred during a rather severe local duststorm in Ramsey County on the 27th.

Over southern portions of the Great Plains area the duststorms occurred chiefly during the first half or immediately after the middle of the month, while farther north they were most frequent after the 17th.

NOVEMBER

Precipitation was again subnormal over a large northern and central area; percentages in portions of the Great Plains ranged from only 27 in Nebraska to 85 in Texas. Kansas received only 51 percent of the normal November fall. A letter from the official in charge at Dodge City, Kans., dated November 30th states:

> Up to the present time, the fall months of the year 1937 have been much drier than any of a like period since the beginning of the present dry cycle. Consequently the soil in this vicinity is much drier both at surface and subsoil. Conditions for blowing soil and dust are perhaps greater, at least in this immediate locality, than in any of the last several years.

Despite the general deficiency in precipitation only a few duststorms, mostly local in character, should be classified as dense, although there were occasional reports of zero visibility during the first half of the month from scattered stations in Wyoming, Nebraska, Kansas, and Oklahoma, and of 200 yards at Holly, Colo., on the late afternoon and early evening of the 27th.

Light dust was again reported from Texas northward to the Canadian border, but the number of days with dusty conditions, ranging from 1 to as many as 5 in drier portions of the area, was much less than in months just preceding.

The only heavy duststorm in Oklahoma occurred at Goodwell, Texas County, on the 26th–27th. Days with light to moderate dust were the 5th, 7th, 13th, 15th, 17th, 26th, and 27th; nearly all the dust was confined to the Panhandle. In Kansas duststorms of moderate intensity occurred in a few western counties on the 7th and in many parts of the western third of the State on the 12th; at Dodge City the duststorm on November 12 was sufficiently heavy to stop the automatic sunshine recorder.

On the 12th visibility in Colorado was reduced to one-fourth mile at times over the greater portion of the South Platte Valley and the Arkansas-Platte Divide, and to 1 mile in the Arkansas Valley east of the 104th meridian. Baca County had numerous days with light dust but no serious damage or discomfort resulted; the only dense duststorm in Colorado was the one at Holly mentioned above.

Western Nebraska reported locally dense dust on the 12th and 27th; local dust blowing occurred at scattered places in the eastern two-thirds of South Dakota on the 1st, 4th, 11th–15th, and duststorms were general throughout south-central North Dakota on the first day of the month.

At Rock Springs, Wyo., dusty conditions prevailed on the 11th with visibility reduced to zero occasionally between 7:30 and 8 p. m.

DECEMBER

Only 8 States west of the 90th meridian received subnormal precipitation during the last month of the year. These were Minnesota, Wisconsin, Louisiana, New Mexico, and the Plains States from South Dakota southward to and including Oklahoma. Percentages of normal in these States varied from only 42 in Nebraska to 98 in South Dakota. All States, except Ohio, to the east of the Mississippi River had subnormal falls.

No dense dust was reported during December and light dust was noted only in Montana, Wyoming, South Dakota, Nebraska, Kansas, and Oklahoma. Montana had light dust on 3 days, the 16th, 18th, and 30th, and all these storms were local in character. Dusty conditions were noted in Wyoming on the 5th and 6th, in South Dakota on the 7th and 31st, and considerable dust was reported in western Kansas on the 2d, with light, local storms on the 21st, 23d, 27th, and 31st. At Dodge City, Kans., the wind movement for December was the lowest for many years, which probably explains why dust occurred on so few dates. Goodwell, Okla., had light dust on the 2d and 30th, but no heavy dust was noted at that, or any other Oklahoma station, during the month.

The year closed with precipitation much below normal over a large central and northern area and duststorms, occasionally severe and resulting in considerable damage to winter grains, were reported in early January.

This paper has been compiled from the numerous reports collected and sent in by the various officials in charge and section directors of the States referred to from time to time. The reports from S. D. Flora, Topeka, Kans.; A. E. Osborn, Dodge City, Kans.; W. H. Wahlgren, Oklahoma City, Okla.; W. E. Maughan, Helena, Mont.; O. R. Roberts, Bismarck, N. Dak.; Thomas A. Blair, Lincoln, Nebr.; and H. F. Choun, Denver, Colo., have been extremely helpful and in some cases have been quoted verbatim.

WEATHER OF 1937 IN THE UNITED STATES

By J. P. KOHLER

[Weather Bureau, Washington, D. C., February 1938]

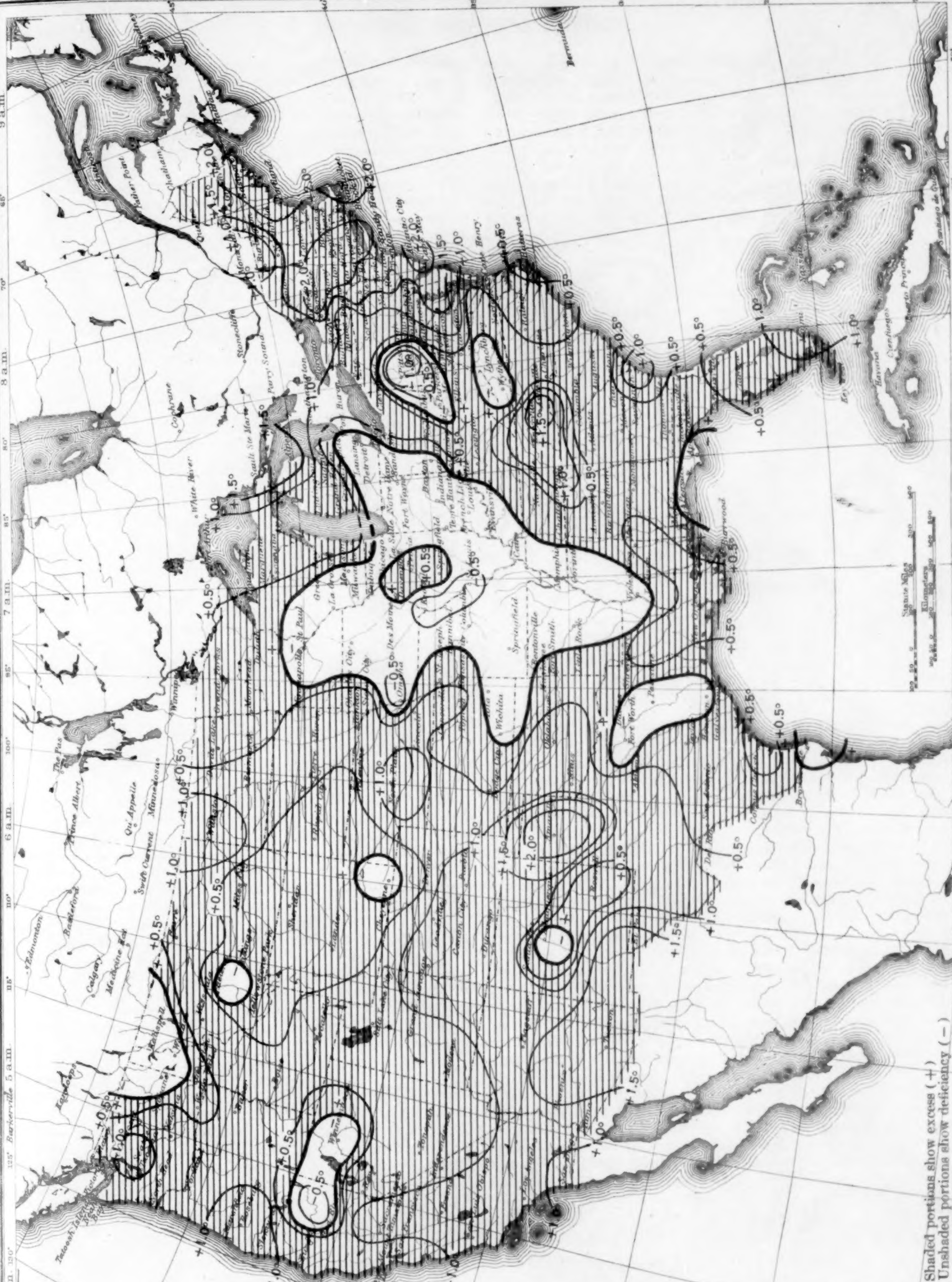
The outstanding event associated with the weather of the year was the great flood in the lower Ohio and Mississippi Valleys brought about by excessive rains in January over the drainage areas of the Ohio River and its tributaries, including the Wabash, the Cumberland, and the Tennessee. The monthly rainfall over the middle and southern portions of Ohio ranged consistently from above 9 inches to more than 14 inches. Over southern Indiana rainfall averaged 16.22 inches (12.20 inches above the average), in southern Illinois 11.74 inches or more than 8 inches in excess of normal. Over central Tennessee monthly falls averaged more than 16 inches and in the western division about 18.50 inches. McKenzie, Tenn., reported 23.90 inches for the month, Earlington, Ky., 22.97, Hickory, Miss., 21.48, and Evans Landing, Ind., 21.39 inches; also monthly totals for Jeffersonville, Ind., and Leavenworth, Ind., were in excess 20 inches. Many stations in southeastern Missouri and eastern Arkansas reported monthly totals in the neighborhood of 20 inches. Statistics covering the area of overflow and the damage of all kinds are not yet available, but probably will surpass all other previous great floods in the United States. A detailed discussion of rainfall over the various watersheds, river stages, and meteorological phenomena responsible for the heavy rains in the Ohio Valley during January appears in Supplement No. 37 of the MONTHLY WEATHER REVIEW.

Among other notable features of the year's weather were: The severe cold of January throughout the Rocky Mountains, north-central Great Plains and upper Mississippi Valley when mean State temperatures were the lowest of record in Washington, Oregon, California, Idaho, Nevada, Utah, Arizona, Montana, Wyoming, Colorado, and New Mexico, and the lowest of January record in the Dakotas and Nebraska, and the exceptionally warm January weather in the southeastern States, particularly in Alabama, which advanced vegetation, especially fruit, to premature stages only to be severely damaged by cold weather during March. Other features were low January temperatures in California which resulted in two destructive freezes, the backward spring weather in the northern Rockies and northern Plains States, the unusually dry spring in Montana and in the north and central Plains which was followed by the most devastating drought ever known in the extreme northeastern counties of Montana.

Drought conditions that were record breaking prevailed over Kansas almost throughout 1937; the year's moisture was deficient in every county, except those in the southeastern quarter. Near the close of the year the lack of normal rainfall in late summer and early fall months

Annual Temperature Departures (°F) in the United States, 1937

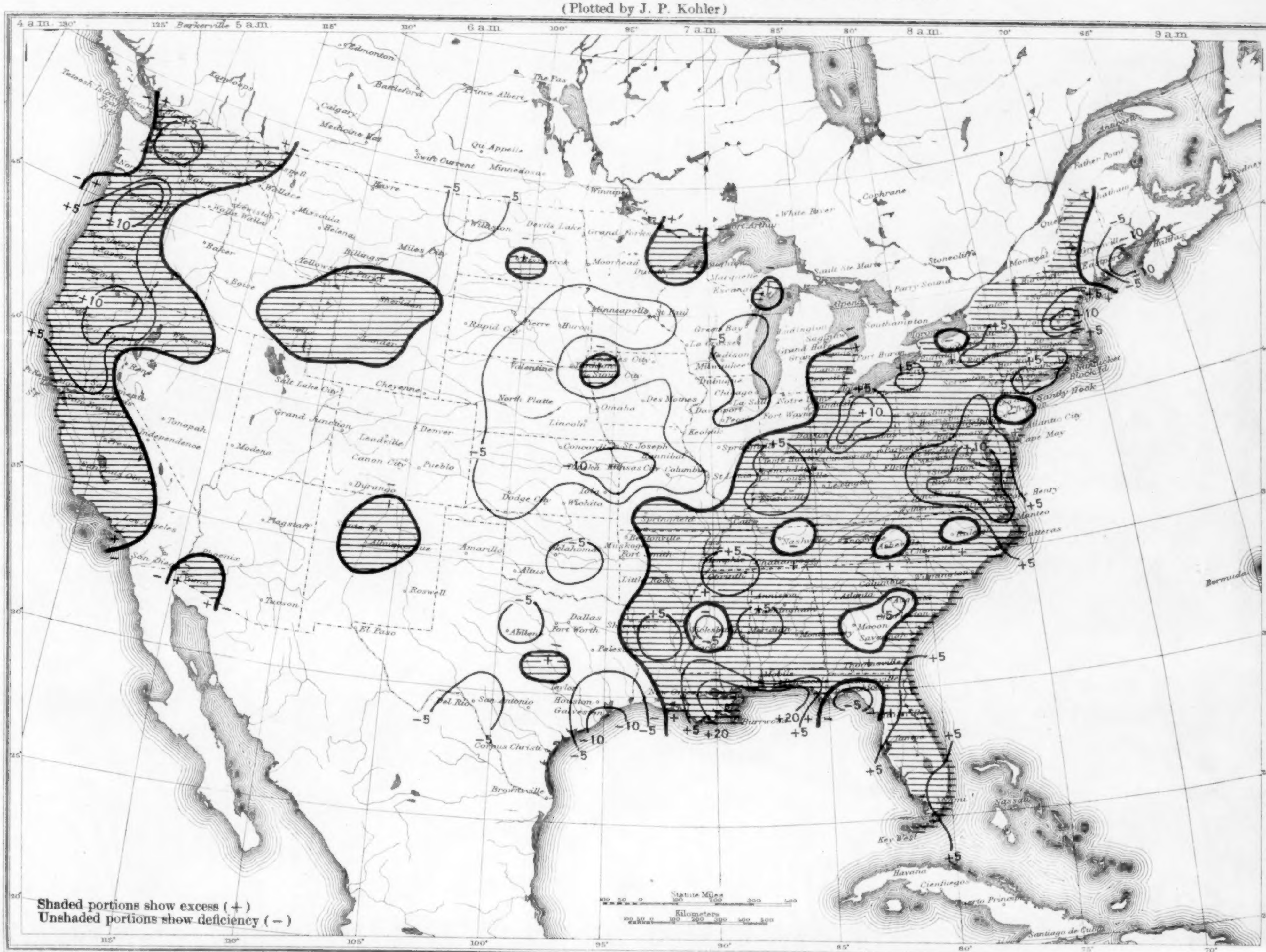
(Plotted by J. P. Kohler)



Shaded portions show excess (+)
Unshaded portions show deficiency (−)

Annual Precipitation Departures (inches) in the United States, 1937

(Plotted by J. P. Kohler)



seriously hampered plowing and seeding of late grains in the northern portions of the Missouri and Mississippi Valleys.

Another notable, but desirable, feature of the year's weather was the marked freedom from destructive storms such as tornadoes which entailed great loss of life and property in the spring months of 1936, especially in the Southeastern States.

Notwithstanding the extremely low temperatures in the western half of the country during January, the year 1937 averaged 0.7° above normal. Table 1 shows, indirectly, that the mean temperatures in practically all districts averaged close to normal. Only one district, the upper Mississippi Valley, averaged below normal warmth. The Ohio Valley and Tennessee district was exactly normal while in all other sections the annual mean temperature was above normal, but generally not more than 1°, except that in the Atlantic coast regions, and sections bordering on the Pacific Ocean, departures ranged from 1° to 2° above normal. In 1936, the upper Lake region was the only section with below-normal warmth while in the remaining districts departures were positive and generally considerably greater as compared to 1937.

TABLE 1.—*Monthly and annual mean temperature departures, 1937*

[Compiled from "Table 2.—Climatological Data for Weather Bureau Stations" contained in the 12 issues of the REVIEW during 1937]

Districts	January	February	March	April	May	June	July	August	September	October	November	December	Annual
New England	+9.3	+5.5	−1.5	−0.1	+2.5	+1.0	+1.7	+4.8	+0.1	−0.8	+2.1	−0.6	+2.0
Middle Atlantic	+9.6	+2.1	−1.8	−.3	+1.7	+1.9	+.7	+2.7	−1.9	−2.0	+.4	.0	+1.1
South Atlantic	+11.3	−.4	−.7	−.2	+.6	+2.4	+.3	+1.2	−.7	−2.4	−2.1	−1.6	+.6
Florida Peninsula	+9.5	+1.6	−1.0	+.2	+.2	+.8	+.1	+.4	+.3	−.7	−1.7	−1.7	+.7
East Gulf	+11.3	−.8	−3.0	−.2	+1.5	+1.8	.0	+1.0	−.9	−2.3	−3.5	−.9	+.3
West Gulf	−.2	+.4	−4.5	.0	+1.4	+1.8	+.4	+2.5	+1.2	+.6	−2.5	−.3	+.1
Ohio Valley and Tennessee	+8.2	−.4	−3.3	−.4	+.2	+1.4	−.4	+3.0	−1.6	−3.0	−2.5	−1.8	.0
Lower Lakes	+7.8	+3.6	−3.2	−.2	+.8	+.2	+1.2	+4.4	−1.2	−2.7	+.1	−1.8	+.8
Upper Lakes	+1.9	+3.1	−1.3	−.2	+1.9	+.6	+2.3	+5.7	+.3	−2.7	−.4	−2.0	+.8
North Dakota	−12.6	−1.4	+1.7	−.1	+3.4	+1.1	+3.7	+7.4	+1.6	+.9	−1.1	−.7	+.3
Upper Mississippi Valley	−2.3	−.9	−1.7	−1.0	+1.5	+.1	+1.9	+5.7	+.9	−1.7	−2.4	−1.9	−.2
Missouri Valley	−8.2	−.7	−1.4	−.8	+2.9	+1.1	+3.6	+7.6	+2.6	−.3	−2.1	−.5	+.3
Northern Slope	−16.6	−.9	+.3	.0	+3.6	+.4	+3.9	+3.6	+3.8	+4.5	+1.1	+1.3	+.4
Middle Slope	−8.2	+.3	−3.0	+.4	+3.1	+1.0	+3.3	+6.2	+2.5	+1.1	−1.2	−.4	+.4
Southern Slope	−3.0	+1.6	−4.2	+1.3	+1.8	+1.5	+1.7	+4.5	+3.1	+2.8	−.4	+.1	+.9
Southern Plateau	−6.7	−1.6	−1.8	+.6	+2.9	+.4	+1.5	+3.6	+3.8	+2.9	+3.0	+4.2	+1.1
Middle Plateau	−15.8	−3.1	+.7	−1.9	+4.8	+.6	+2.6	+2.4	+3.8	+2.9	+4.1	+4.7	+.5
Northern Plateau	−15.1	−2.9	+1.6	−2.2	+2.5	+.5	+3.8	−.3	+4.0	+5.1	+4.0	+4.9	+.5
North Pacific	−7.9	−.3	+2.6	−1.2	+1.4	+2.6	+1.4	+.2	+1.8	+4.6	+3.4	+2.8	+1.0
Middle Pacific	−10.3	−2.8	+.4	−1.3	+1.7	+1.8	+1.9	+1.6	+1.2	+2.4	+1.8	+3.9	+.2
South Pacific	−5.8	−.3	+.7	+1.4	+2.2	+.7	+1.2	+.7	+2.5	+2.4	+1.3	+4.7	+1.0
United States	−2.1	+.8	−1.2	−.3	+2.0	+1.1	+1.8	+3.3	+1.3	+.6	+.1	+.6	[1]+.7

[1] Mean of the monthly values.

The relatively warmest section for the year was the New England district which averaged 2° above normal. The relatively warmest month was August with a departure of 3.3°. May, June, July, and September were also considerably warmer than normal and February, October, November, and December averaged slightly above normal. Only three months, January, March, and April for the country as a whole, averaged subnormal warmth; January was the relatively coldest month with a negative departure from normal of 2.1°. Close examination of table 1 shows that January was characterized by marked contrasting temperature conditions in different portions of the country. Decidedly above-normal warmth prevailed in the Northeast and Ohio Valley and Tennessee while west of the Mississippi River and the Lake region temperatures, especially the Plateau and Rocky Mountain districts, were markedly below normal. Deviations from the normal by districts during the remaining months of the year were much less marked, except that during August excessive warmth prevailed in North Dakota, the upper Mississippi Valley and middle Slope districts.

Chart I, based on data furnished by 170 first- and second-order stations, as compared to table 1, offers a less generalized summation of temperature conditions for the year. It shows a large interior area of subnormal warmth while the remainder of the country, except small local areas, averaged above normal.

During the past year, although precipitation was not normal over a large interior section and July and August were comparatively hot, it was a decided improvement over conditions which existed in 1936. On a State average basis only 5 States west of the Mississippi River, viz, Texas, Arizona, Colorado, Utah, and Nevada, had less annual rainfall than in 1936. All States which suffered severely from the lack of rainfall in 1936 received in 1937 substantial increases apart from small gains, 10 percent or less, in Iowa, Kansas, and Montana. East of the Mississippi River and the Lake region the annual rainfall, without exception, averaged above normal, as well as in the Pacific Coast States.

Table 2 shows that for the United States as a whole precipitation averaged 0.4 inch in excess of normal or about 2.1 inches above the corresponding 1936 figure. In 10 of the 21 climatological districts, comprising the area westward from the upper Lakes to the northern slope and southward to the Mexican border and west Gulf district, there was a decided shortage in rainfall. The relatively driest sections were the Missouri Valley and middle and southern slope districts (in 1936, 14 sections received less-than-normal precipitation). Annual averages were decidedly in excess of normal in the Atlantic coast and east Gulf sections and also in the north and middle Pacific districts, the middle Pacific district (principally northern California) being the relatively wettest with an excess of 8.8 inches.

TABLE 2.—*Precipitation departures, monthly and annual, 1937*

[Compiled from "Table 2—Climatological data for Weather Bureau Stations" contained in the 12 issues of the REVIEW during 1937]

Districts	January	February	March	April	May	June	July	August	September	October	November	December	Sum
New England	+0.6	−1.3	−0.1	+1.0	+0.4	+1.2	−1.3	+0.7	+0.1	+1.1	+1.5	−0.5	+3.4
Middle Atlantic	+2.8	−.7	−1.2	+1.6	−.7	+1.1	−.9	+1.8	−.8	+2.7	+.7	−1.9	+4.5
South Atlantic	+1.6	+.3	−1.6	+2.7	−1.3	−.3	+.7	.0	−1.2	+1.2	+.4	−1.4	+1.1
Florida Peninsula	−1.1	+4.2	+1.7	−.3	+.6	−1.0	+.6	−.2	+1.1	−.6	+.7	−1.2	+4.5
East Gulf	+2.5	.0	−.8	+3.1	−.4	.0	−1.8	+1.1	−.1	+4.8	−.8	−2.3	+5.3
West Gulf	+1.7	−1.5	+.6	−2.4	−1.8	−.3	−.8	−.7	−.7	+.5	+.5	+2.4	−2.5
Ohio Valley and Tennessee	+8.3	−1.2	−2.5	+.5	−.1	+.3	−.2	+.4	−.9	+2.1	−1.5	−.2	+5.0
Lower Lakes	+2.1	−.4	−.7	+1.7	−.4	+2.8	−.2	+.7	−1.2	+1.0	−.8	−.4	+4.2
Upper Lakes	+.6	+.1	−1.3	+1.1	−1.2	−.2	−.4	−.5	+.4	−.1	−.1	−.6	−2.2
North Dakota	+.3	.0	−.5	+1.0	−.8	−.6	+.3	−.2	−.1	−.5	−.3	.0	−1.4
Upper Mississippi Valley	+2.5	−.2	−.9	+.8	−.2	−.2	−1.2	−1.1	−1.4	+.2	−.8	−.1	−2.6
Missouri Valley	+1.4	−.8	−.2	−.4	−1.1	−.5	−.6	−.8	−2.0	−.8	−.5	−.3	−6.6
Northern Slope	.0	−.1	+.3	−.4	−1.1	+.2	+.4	−.6	−.4	−.3	−.2	+.3	−1.9
Middle Slope	+.4	−.4	+.2	−1.2	−1.4	−.2	−.6	−.9	−.7	−.6	−.2	−.2	−5.8
Southern Slope	−.3	−.6	+.3	−1.0	+.6	−.8	−1.5	−1.2	−.5	−.6	−.4	+1.0	−5.0
Southern Plateau	+.1	+.2	+.4	−.4	+.5	+.7	−.7	−.8	+.4	−.1	−.6	−.2	−.5
Middle Plateau	+.3	.0	+.2	−.3	−.3	−.4	+.5	−.3	−.2	−.3	+.1	+.4	−.3
Northern Plateau	−.1	−.2	+.2	+.7	−1.0	+.5	−.1	−.2	−.3	−.2	+.7	+.2	+.2
North Pacific	−2.9	+1.1	−1.1	+2.8	−.7	+1.9	−.4	+.6	−.2	−.2	+3.4	+1.0	+5.3
Middle Pacific	−1.8	+1.2	+3.5	+.5	−1.0	+.8	.0	.0	−.6	+.9	+3.9	+.4	+8.8
South Pacific	−.5	+2.7	+1.0	−.7	−.2	−.1	.0	.0	−.2	−.6	−.9	+.6	+1.1
United States	+.9	+.1	−.2	+.5	−.6	+.2	−.4	−.1	−.5	+.5	+.2	−.2	[1] +.4

[1] Sum of the 12 monthly values.

On a monthly basis variations from normal precipitation were equally divided. January, February, April, June, August, and November received above normal amounts. January was by far the wettest month with an excess of 0.9 inch and May the relatively driest with a deficiency of 0.6 inch.

Chart II, constructed from data furnished by 174 first- and second-order stations, shows the yearly distribution of precipitation with respect to normal. There appears a large area of decidedly deficient rainfall over northeastern Kansas, southeastern Nebraska, and northern Missouri with a smaller area of marked shortage of moisture in Oklahoma and along the West Gulf coast and immediate interior. Areas of markedly above-normal rainfall prevailed east of the Mississippi River and the Lake region and in the north and middle Pacific Coast States. The largest yearly excess reported from a first-order station was 29.73 inches at Pensacola, Fla.; New Orleans, La., had 21.94 inches in excess of the yearly normal. Similarly, the greatest shortage reported was 14.12 inches at Topeka, Kans., and Kansas City, Mo., was close with 12.27 inches below annual normal rainfall.

Temperature extremes during the year were well within the limit of previous records. The highest maximum reported was 124° at Greenland Ranch, Calif., on August 11, 12, and 13 and at Cow Creek, Calif., on the 12th. The lowest temperature reported was −56° at West Yellowstone, Wyo., on January 21. Temperatures of freezing or below occurred in every State some time during the 12 months. July brought minima of freezing or below to 12 States and August brought similar minima to 10 States. The lowest for July was 20° at Austin, Oreg., on the 8th; and that for August was 13° at Seneca, Oreg., on the 28th.

The greatest annual precipitation recorded at any station in the United States during the year was 168.88 inches at Valsetz, Oreg., elevation, 1,150 feet; this station also reported the greatest monthly amount in the United States, 35.96 inches in December. During the year 1,204 stations experienced at least 1 month with no precipitation and 66 stations had months with totals of less than 0.01 inch.

NOTES AND REVIEWS

Note on Early Tornadoes in Georgia. By GEORGE W. MINDLING. In connection with the preparation of a summary of such data as could be found on tornadoes in Georgia during years preceding those covered by the Weather Bureau *Climatological Data*, the writer listed the tornadoes that are given as having occurred in Georgia in the well-known work of Finley, *Report on the Character of Six Hundred Tornadoes*, Professional Papers of the Signal Service, No. VII.

Correspondence was carried on with many newspaper offices in an effort to obtain some additional information about the early Georgia tornadoes listed in Finley's paper. There are only two instances in which this correspondence brought to light any errors or new information, which is a favorable indication of the general reliability of Finley's work: Two of the Georgia tornadoes listed in his report did not occur, viz, the one of April 3, 1880, at Toccoa, Ga., and one of April 4, 1880, in Washington County, both listed on page 16 of the Report.

Complete assurance has been obtained, through newspaper offices and others in Toccoa, that no tornado such as listed in Finley's work ever occurred at or near that place. The report indicates the destruction of 50 buildings and the loss of three lives. Toccoa was a very small place in 1880 and probably did not have 50 buildings at that time.

C. B. Chapman of the *Sandersville Progress* has furnished an account of a tornado that occurred in Davisboro, Washington County, at 6 p. m., February 18, 1884. This report was confirmed by Mamie S. Harris, whose brother lived in Davisboro when the town was wrecked by this tornado. Neither of these correspondents could find any one to confirm the occurrence of the tornado listed as occurring in the county on April 4, 1880.

E. W. HEWSON. A Survey of the Facts and the Theories of the Aurora. *Reviews of Modern Physics*, Vol. 9, pp. 403–431, 1937 October.

This paper provides a summary of present knowledge of the aurora, with bibliographic references to 81 papers.

The types of aurora and their geographical distribution are described; and the variations in auroral activity and their relation to magnetic storms and earth currents are discussed. The determination of auroral heights is given an extended treatment. Intensity measurements, the differences in the characteristics of ordinary auroras and sunlit auroras, and the auroral spectrum are discussed in detail. The theories of the aurora which are outlined include the corpuscular theory of Störmer, and the investigations of Chapman and Ferraro, and of Milne; and the secondary corpuscle theory or ultraviolet light theory of Maris and Hulbert.—*Edgar W. Woolard.*

BIBLIOGRAPHY

[RICHMOND T. ZOCH, *in Charge of Library*]

By AMY D. PUTNAM

RECENT ADDITIONS

The following have been selected from among the titles of books recently received as representing those most likely to be useful to Weather Bureau officials in their meteorological work and studies:

American geophysical union.
Seventeenth annual meeting. Transactions. April 30, May 1, 2, 1936. Washington, July 1936. illus., maps, tables, diagrs. 25 cm.

Baur, Franz.
Einführung in die grosswetterforschung. Leipzig und Berlin. 1937. 51 p. illus. (charts), diagrs. 18½ cm.

Bennett, H. H.
Unmaking a continent. Address before the Brooklyn institute of arts and sciences, Brooklyn Academy of Music, April 22, 1937. Washington. 1938. 18 p. 27 cm. [Mimeographed.] (U. S. Soil conservation service.)

Brunt, David.
Weather science for everybody. London. 1936. 170 p. front., illus. (charts), plates, diagrs. 19 cm.

Byrd, Richard Evelyn.
Exploring with Byrd; episodes from an adventurous life. New York. 1937. 241 p. front., plates, ports. 22½ cm.

Curtman, Louis Jacob.
A brief course in qualitative chemical analysis, from the standpoint of the laws of equilibrium and the ionization theory. New York. 1936. 249 p. illus., diagr. 22 cm.

Friez, Julien P.
Portable water level recorders. Model FW. Baltimore. [n. d.] unp. illus. 28 cm.

Friez, Julien P., & Sons.
Standard weather instruments. Baltimore. • 1937. 101 p. illus., tables, diagrs. 28 cm.

Friez, Julien P.
The weatherman. Baltimore. [n. d.] 16 p. illus. 28 cm.

Früh, Jacob.
Geographie der Schweiz. St. Gallen, Fehr, Band 3, 1938. illus., fold. plates (incl. maps). 27 cm.

Gherzi, Ernesto.
Typhoons in 1934 (set caused by tropical cyclones.) [Shanghai]. 1936. 43 p. 4 fold. charts, fold. tab. 24 cm. [Zi-ka-wei observatory.]

Hall, Henry Sinclair.
Higher algebra; a sequel to Elementary algebra for schools. 4th ed. London. 1929. 557 p. 18½ cm.

Hankó, Martin.
Astrometeorologie und Astroseismologie. Dunántúl. 1935. 136 p. 22½ cm.

Journal of Marine Research.
Published by Sears foundation for marine research. Bingham Oceanographic Laboratory, Yale university. Vol. 1, 1937/38- No. 1- (issued November 17, 1937.)

Knudson, Vern O.
The absorption of sound in gases. [Menasha, Wisconsin.] 1935. p. 199-204, table, diagrs. 27 cm. [Reprinted from The Journal of the Acoustical society of America, Vol. VI, No. 4, April, 1935.]

Kobronov, N.
The settling of ice on trees and measures to be taken against injuries inflicted to them by ice coating. Leningrad. 1936. 22 p. illus., tables, diagrs. 23 cm. [Mitteilungen der Forsttechnischen Akademie, No. 47, 1936.]

Miller, Harold Blaine.
Navy wings. New York. 1937. 323 p. front., plates, ports. 22 cm.

Missenard, André.
L'homme et le climat; préface du docteur Alexis Carrel. Paris. [1937.] 270 p. 20 cm.

Shepard, Harold Blaisdell.
Forest fire insurance in the Pacific coast states. Washington. 1937. [cover-title] 168 p. maps, facsims. 23 cm. (U. S. Dept. of agriculture Technical bulletin no. 551.)

Storm loading and strength of wood pole lines and a study of wind gusts; an experimental and analytical study of storm loading, and strength during storms, of electric power distribution lines, by R. H. Sherlock *and others*. [New York, Edison electric institute, 1936.] 183 p. illus., pl., tables (1 double), diagrs. 23½ cm.

Stumpff, Karl. Grundlagen und methoden der Periodenforschung. Berlin. 1937. 332 p. illus., tables, diagrs. 24 cm.

U. S. Hydrographic office.
Radio aids to navigation including details of direction-finder stations, radiobeacons, weather bulletins, storm and navigational warnings, time signals, etc. Corrected to December 9, 1936. Washington. 1937. 530 p. tables, diagrs. 23 cm.

U. S. Library of Congress. Division of aeronautics.
Aeronautical periodicals and serials in the Library of Congress. Washington. 1937. 27 cm. [Mimeographed.]

Uspensky, James Victor.
Introduction to mathematical probability. 1st ed. New York and London. 1937. 411 p. diagrs. 23½ cm.

Weld, LeRoy Dougherty.
Glossary of physics. 1st ed. New York and London. 1937. 255 p. 21 cm.

Williams, George Bransby.
Storage reservoirs. London. 1937. 293 p. illus. (incl. maps), plates, diagrs. (part fold.) 22½ cm.

Zimmer, Karl Günther.
Strahlungen; wesen, erzeugung und mechanismus der biologischen wirkung. Leipzig. 1937. 72 p. diagrs. 21 cm.

SOLAR OBSERVATIONS

[Meteorological Research Division, EDGAR W. WOOLARD in charge]

SOLAR RADIATION OBSERVATIONS, JANUARY 1938

By IRVING F. HAND

Measurements of solar radiant energy received at the surface of the earth are made at eight stations maintained by the Weather Bureau, and at nine cooperating stations maintained by other institutions. The intensity of the total radiation from sun and sky on a horizontal surface is continuously recorded (from sunrise to sunset) at all these stations by self-registering instruments; pyrheliometric measurements of the intensity of direct solar radiation at normal incidence are made at frequent intervals on clear days at three Weather Bureau stations (Washington, D. C., Madison, Wis., Lincoln, Nebr.) and at the Blue Hill Observatory of Harvard University. Occasional observations of sky polarization are taken at the Weather Bureau stations at Washington and Madison. Measurements of the intensity of direct solar radiation through Schott color filters, for the determination of atmospheric turbidity and precipitable water vapor, are conducted at Washington and Blue Hill.

The geographic coordinates of the stations, and descriptions of the instrumental equipment, station exposures, and methods of observation, together with summaries of the data obtained up to the end of 1936, will be found in the MONTHLY WEATHER REVIEW, December 1937, pp. 415 to 441; further descriptions of instruments and methods are given in Weather Bureau Circular Q.

Table 1 contains the measurements of the intensity of direct solar radiation at normal incidence, with means and their departures from normal (means based on less than 3 values are in parentheses). At Madison and Lincoln the observations are made with the Marvin pyrheliometer; at Washington and Blue Hill they are obtained with a recording Eppley thermopile, checked by observations with a Marvin pyrheliometer at Washington and with a Smithsonian Silver Disk pyrheliometer at Blue Hill. The table also gives vapor pressures at 8 a. m. (seventy-fifth meridian time) and at noon (local mean solar time).

During January 1938 direct solar radiation intensities averaged below normal at Washington and Blue Hill, and very slightly above normal at Lincoln. So few observations were taken at Madison that the departures from normal for that station are meaningless.

Table 2 contains the average amounts of radiation received daily on a horizontal surface from both sun and sky during each week, their departures from normal and the accumulated departures since the beginning of the year. The values at most of the stations are obtained from the records of an Eppley pyrheliometer recording on either a microammeter or a potentiometer.

During January 1938 all stations show a deficiency in the total solar and sky radiation for the month with the exception of New York, Fairbanks, New Orleans, Riverside, Blue Hill, San Juan, and Friday Harbor. It is interesting to note that with the exception of the Alaskan station, all the stations with plus departures are located near the coasts.

For the determination of atmospheric turbidity and precipitable water, the intensity of direct solar radiation at normal incidence is measured, with and without color filters, by a thermopile recording on a potentiometer. The publication of table 3 is temporarily suspended, during a reinvestigation of the transmission of the filters.

No polarization measurements were made at Madison during January owing to continual snow and ice cover. The polarimeter at Washington has recently been overhauled and observations at this station will begin again when the instrument is installed within a short time.

TABLE 1.—*Solar radiation intensities during January 1938*

[Gram-calories per minute per square centimeter of normal surface]

Date	8 a. m.	Sun's zenith distance 78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass A. M.					P. M.				Local mean solar time
	e	5.0	4.0	3.0	2.0	*1.0	2.0	3.0	4.0	5.0	e
WASHINGTON, D. C.											
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
Jan. 3	2.62	0.64	0.84	0.99				1.00			2.74
Jan. 4	3.81							1.06			3.63
Jan. 5	3.81	.86	1.12	1.27				1.25	0.95		3.45
Jan. 6	3.45	.75	.81	.88							3.99
Jan. 13	2.87		.66	.76							2.74
Jan. 20	2.36	.32	.40	.54							2.74
Jan. 25	7.29			.84							4.37
Jan. 27	1.24			1.02							1.32
Jan. 29	1.37	.59	.70	.95							2.06
Means		.63	.76	.91				1.10	(.95)		
Departures		−.11	−.10	−.11				−.01	−.14		
MADISON, WIS.											
Jan. 27	0.79				1.54						0.79
Jan. 31	.74		1.11								.64
Means			(1.11)		(1.54)						
Departures			+.05		+.18						
LINCOLN, NEBR.											
Jan. 1	2.06	1.06	1.19	1.37			1.50	1.32			2.49
Jan. 3	3.15						1.49	1.34	1.20	1.12	1.24
Jan. 4	1.12	1.05	1.15	1.30							2.49
Jan. 5	1.68				1.56						2.74
Jan. 7	.81	1.06	1.16	1.32	1.55			1.41	.94		.86
Jan. 8	.86	1.00									1.02
Jan. 12	2.36							1.35	1.23	1.07	2.26
Jan. 14	2.26						1.51				2.16
Jan. 22	3.81	1.00	1.11	1.22	1.36			1.23	.98	.92	4.95
Jan. 25	.79	.92		1.20				.79	.60	.40	.56
Jan. 26	.86				1.56						.79
Jan. 27	1.37	1.05	1.14	1.31	1.49		1.50	1.28	.88	.72	1.07
Jan. 28	1.96	.89	1.02	1.19	1.35		1.15				2.74
Jan. 30	.86						1.43	1.34	1.21	1.10	.66
Jan. 31	.58	1.01	1.14	1.24	1.44						.79
Means		1.00	1.13	1.27	1.47		1.43	1.25	1.03	.92	
Departures		+.08	+.08	+.07	+.08		+.02	+.07	−.02	−.01	
BLUE HILL, MASS.											
Jan. 3	2.9	0.99	1.06	1.13	1.19	1.31	1.19	1.13	1.07	1.01	2.3
Jan. 6	2.9	.68	.77	.89	1.01						3.8
Jan. 8	2.9			1.02	1.30		1.00	.88	.77	.66	2.9
Jan. 9	1.5	1.00	1.09	1.15	1.29		1.28	1.08	.90		1.5
Jan. 12	1.3	.98	1.07	1.14	1.24						2.6
Jan. 15	1.7				1.18		1.14				1.7
Jan. 16	1.1		.97	1.18	1.43						1.4
Jan. 18	1.1			1.26	1.20						1.0
Jan. 19	.7	1.17	1.28	1.40	1.40		1.32	1.19			1.1
Jan. 26	2.0	.85	.95	1.08	1.22						2.0
Jan. 27	1.5	.76	.86	.97	1.13						1.5
Jan. 28	1.3		1.02	1.08	1.43		1.43	1.25	.92		1.3
Jan. 29	1.4		.85	.95	1.11						1.6
Jan. 30	3.2			.72	1.00		.99	.98			4.6
Means		.92	.99	1.07	1.22	1.31	1.19	1.08	.92	.84	
Departures		−.01	−.03	−.06	−.08		−.13	−.09	−.13	−.10	

*Extrapolated.

TABLE 2.—*Average daily totals of solar radiation (direct+diffuse) received on a horizontal surface*

Week beginning—	Washington	Madison	Lincoln	Chicago	New York	Fresno	Fairbanks	Twin Falls	La Jolla	Miami	New Orleans	Riverside	Blue Hill	San Juan	Friday Harbor	Ithaca	Newport
	Gram-calories per square centimeter																
	cal.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Jan. 1	181	136	217	104	113	114	8	130	264	304	170	241	137	421	83	62	108
Jan. 8	128	95	154	83	100	82	21	97	290	273	182	257	169	465	61	77	149
Jan. 15	72	75	107	64	126	195	14	105	240	326	209	229	198	402	107	129	234
Jan. 22	143	156	245	99	137	241	49	184	336	307	288	320	167	465	89	117	171
	Departures of daily totals from normals																
Jan. 1	+28	+8	+43	+22	+9	−34	+1	−29	+20	+8	+10	+3	0	+61	+74	−28	....
Jan. 8	−21	−38	−31	+1	−7	−76	+11	−64	+26	−21	−18	+26	+18	+67	−15	−4	....
Jan. 15	−83	−77	−87	−32	+16	+1	+1	−71	−36	+44	+6	−44	+34	−12	+11	+32	....
Jan. 22	−32	−28	+16	−19	−13	+14	+20	−4	+50	−22	+91	+47	−22	+29	−6	−27	....
	Accumulated departures since Jan. 1																
	−756	−945	−413	−196	+35	−665	+231	−1,176	+420	+63	+623	+224	+210	+915	+28	−189	....

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. J. F. Hellweg, U. S. Navy (Ret.), Superintendent, U. S. Naval Observatory. Data furnished by the U. S. Naval Observatory in cooperation with Harvard and Mount Wilson Observatories. The difference in longitude is measured from the central meridian, positive west. The north latitude is positive. Areas are corrected for foreshortening and are expressed in millionths of the sun's visible hemisphere. The total area for each day includes spots and groups]

Date	Eastern standard time		Mt. Wilson group number	Heliographic: Diff. in longitude	Heliographic: Longitude	Heliographic: Latitude	Area: Spot or group	Area: Total for each day	Spot count	Observatory
1938	*h.*	*m.*		°	°	°				
Jan. 1	12	47	5713	−61.0	23.9	+5.0	121	....	4	Mt. Wilson.
			5714	+6.0	90.9	+15.0	24	....	7	
			5712	+6.5	91.4	−15.5	170	....	19	
			5704	+23.0	107.9	+15.5	145	....	27	
			5707	+37.0	121.9	+19.0	242	....	19	
			5709	+53.0	137.9	−16.0	218	....	23	
			5699	+64.0	148.9	−11.0	97	....	4	
			5703	+71.0	155.9	−19.0	97	1,114	12	
Jan. 3	11	14	5716	−45.0	14.4	+16.0	97	....	11	U. S. Naval.
			5713	−34.5	24.9	+5.5	145	....	4	
			5715	+19.0	78.4	+38.5	97	....	7	
			5712	+36.0	95.4	−14.0	121	....	16	
			5704	+57.0	116.4	+15.0	97	....	14	
			5707	+63.0	122.4	+20.0	339	....	11	
			5709	+80.0	139.4	−17.0	339	1,235	14	
Jan. 4	10	50	5718	−81.0	325.5	+9.0	48	....	1	Do.
			5717	−74.0	332.5	+9.0	48	....	1	
			5716	−32.0	14.5	+15.0	242	....	22	
			5713	−21.5	25.0	+5.5	158	....	5	
			5715	+29.0	75.5	+37.5	97	....	2	
			5712	+58.0	104.5	−13.5	145	....	4	
			5704	+63.0	109.5	+18.0	48	....	1	
			5707	+76.0	122.5	+20.0	436	1,222	5	
Jan. 5	11	4	5719	−75.0	318.1	+20.0	48	....	3	Do.
			5718	−71.0	322.1	+9.0	48	....	1	
			5717	−60.0	333.1	+8.5	24	....	1	
			5716	−19.5	13.6	+14.0	339	....	20	
			5713	−9.0	24.1	+5.0	194	....	14	
			5715	+40.5	73.6	+37.5	97	....	5	
			5712	+66.0	99.1	−14.0	97	847	5	
Jan. 6	10	56	5719	−60.0	320.0	+20.0	97	....	7	Mt. Wilson.
			5718	−58.0	322.0	+9.5	109	....	7	
			5716	−5.0	15.0	+12.5	339	....	24	
			5720	+2.0	22.0	−23.0	24	....	2	
			5713	+6.0	26.0	+4.0	97	....	8	
			5715	+53.0	73.0	+37.0	170	....	6	
			5712	+79.0	99.0	−14.0	97	933	1	
Jan. 7	11	4	5722	−75.0	291.8	−15.0	24	....	1	U. S. Naval.
			5721	−52.0	314.8	+24.5	48	....	4	
			5719	−48.0	318.8	+20.0	206	....	20	
			5718	−45.0	321.8	+9.0	121	....	12	
			5716	+9.0	15.8	+12.0	582	....	45	
			5713	+18.0	24.8	+5.0	48	....	4	
			5715	+66.0	72.8	+37.0	388	1,417	5	
Jan. 8	10	58	5722	−62.0	291.7	−10.0	24	....	1	Mt. Wilson.
			5721	−39.0	314.7	+24.0	73	....	5	
			5719	−37.0	316.7	+20.5	291	....	11	
			5723	−35.0	318.7	−16.5	48	....	3	
			5718	−31.0	322.7	+9.0	121	....	5	
			5716	+22.0	15.7	+12.0	776	....	25	
			5713	+32.0	25.7	+4.5	48	....	3	
			5715	+80.0	73.7	+39.0	267	1,648	2	
Jan. 9	12	0	5722	−49.0	290.9	−15.0	73	....	5	U. S. Naval.
			5721	−25.0	314.9	+24.5	121	....	13	
			5719	−23.0	316.9	+19.5	388	....	27	
			5718	−14.5	325.4	+9.0	97	....	6	
			5716	+36.0	15.9	+11.0	533	....	30	
			5713	+46.0	25.9	+4.0	12	1,224	2	

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard time		Mt. Wilson group number	Heliographic: Diff. in longitude	Heliographic: Longitude	Heliographic: Latitude	Area: Spot or group	Area: Total for each day	Spot count	Observatory
1938	*h.*	*m.*		°	°	°				
Jan. 10	11	34	5,722	−35.0	292.0	−14.0	73	....	6	U. S. Naval.
			5,721	−13.0	314.0	+24.5	121	....	8	
			5,719	−11.0	316.0	+20.0	679	....	28	
			5,724	−11.0	316.0	−13.0	121	....	6	
			5,718	−2.0	325.0	+9.0	97	....	3	
			5,716	+49.0	16.0	+12.0	533	1,624	16	
Jan. 11	11	20	5,725	−76.0	238.0	+25.0	48	....	2	Mt. Wilson.
			5,722	−22.0	292.0	−16.0	48	....	5	
			5,721	+1.0	315.0	+25.0	48	....	4	
			5,724	+3.0	317.0	−13.0	73	....	5	
			5,719	+4.0	318.0	+20.5	582	....	22	
			5,718	+12.0	326.0	+8.5	97	....	6	
			5,716	+63.0	17.0	+12.0	339	1,235	6	
Jan. 12	11	14	5,726	−78.0	222.9	+17.0	679	....	6	Do.
			5,725	−63.0	237.9	+26.0	145	....	5	
			5,722	−10.0	290.9	−16.0	48	....	4	
			5,719	+15.0	315.9	+20.0	921	....	30	
			5,724	+17.0	317.9	−14.0	36	....	2	
			5,718	+26.5	327.4	+8.5	73	....	4	
			5,716	+73.0	13.9	+13.0	242	2,144	4	
Jan. 13	11	27	5,729	−80.0	207.6	+15.0	97	....	2	U. S. Naval.
			5,728	−78.0	209.6	+21.0	36	....	1	
			5,726	−65.0	222.6	+17.0	1,939	....	25	
			5,727	−56.0	231.6	+14.0	170	....	6	
			5,725	−53.0	234.6	+27.0	388	....	13	
			5,722	+5.0	292.6	−16.0	48	....	8	
			5,719	+27.0	314.6	+21.0	1,454	....	30	
			5,718	+40.0	327.6	+9.0	48	....	8	
			5,716	+85.0	12.6	+13.0	48	4,228	1	
Jan. 15	10	45	5,729	−53.0	208.6	+14.0	109	....	2	Do.
			5,728	−47.5	214.1	+21.0	48	....	6	
			5,726	−36.0	225.6	+17.5	2,812	....	110	
			5,727	−25.0	236.6	+15.0	291	....	8	
			5,725	−24.0	237.6	+27.0	218	....	17	
			5,719	+56.0	317.6	+22.0	1,454	....	35	
			5,718	+65.0	326.6	+9.0	48	4,980	8	
Jan. 16	12	31	5,730	−53.0	194.5	−11.0	48	....	4	Mt. Wilson.
			5,729	−38.0	209.5	+13.0	97	....	3	
			5,728	−33.0	214.5	+20.0	48	....	4	
			5,726	−22.0	225.5	+17.0	2,909	....	42	
			5,725	−10.0	237.5	+27.0	121	....	9	
			5,727	−9.5	238.0	+14.0	242	....	8	
			5,719	+69.0	316.5	+22.0	1,261	....	17	
			5,718	+78.0	325.8	+9.0	36	4,762	1	
Jan. 18	10	27	5,732	−78.0	144.3	−14.0	48	....	1	Do.
			5,731	−71.0	151.3	−12.0	48	....	1	
			5,729	−11.0	211.3	+12.5	48	....	2	
			5,726	+4.0	226.3	+17.0	3,151	....	61	
			5,725	+15.5	237.8	+26.5	73	....	4	
			5,727	+17.0	239.3	+13.5	242	3,610	7	
Jan. 19	14	30	5,732	−65.0	141.9	−14.5	36	....	4	Do.
			5,731	−55.0	151.9	−12.0	36	....	8	
			5,734	−51.0	155.9	−21.0	97	....	14	
			5,733	−26.0	180.9	−10.0	85	....	10	
			5,726	+17.0	223.9	+17.0	3,151	....	145	
			5,725	+30.0	236.9	+26.5	24	....	4	
			5,727	+32.0	238.9	+13.5	218	3,647	6	
Jan. 20	10	45	5,736	−80.0	115.8	+22.0	194	....	1	U. S. Naval.
			5,732	−53.0	142.8	−13.5	48	....	1	
			5,731	−45.0	150.8	−11.0	24	....	6	
			5,734	−40.0	155.8	−20.0	206	....	9	
			5,733	−13.0	182.8	−10.0	97	....	8	
			5,735	+17.0	212.8	+19.0	36	....	2	
			5,726	+29.0	224.8	+17.0	2,860	....	44	
			5,725	+40.0	235.8	+27.0	24	....	3	
			5,727	+42.0	237.8	+13.0	206	3,695	1	

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard time	Mt. Wilson group number	Heliographic: Diff. in longitude	Heliographic: Longitude	Heliographic: Latitude	Area: Spot or group	Area: Total for each day	Spot count	Observatory
1938	h. m.		°	°	°				
Jan. 21	11 28	5736	−64.0	118.2	+21.0	145	-------	1	Mt. Wilson.
		5732	−38.0	144.2	−14.0	24	-------	2	
		5739	−24.0	158.2	+12.0	16	-------	1	
		5734	−23.0	159.2	−20.0	97	-------	11	
		5738	−20.0	162.2	+16.0	24	-------	1	
		5737	−1.5	180.7	−14.0	16	-------	2	
		5733	+1.5	183.7	−10.0	170	-------	14	
		5726	+43.0	225.2	+18.0	2860	-------	44	
		5725	+54.0	236.2	+27.0	24	-------	2	
		5727	+56.0	238.2	+13.0	194	3,570	1	
Jan. 22	11 21	5745	−77.0	92.1	−12.5	36	-------	1	Do.
		5744	−70.5	98.6	−6.5	48	-------	1	
		5740	−66.0	103.1	−14.0	16	-------	1	
		5736	−50.0	119.1	+21.0	194	-------	1	
		5743	−49.0	120.1	−8.0	16	-------	3	
		5732	−26.0	143.1	−13.0	16	-------	1	
		5739	−11.0	158.1	+12.0	97	-------	12	
		5742	−9.0	160.1	+6.0	24	-------	3	
		5734	−8.0	161.1	−19.0	97	-------	17	
		5741	+11.0	180.1	+7.0	73	-------	3	
		5733	+14.0	183.1	−10.0	388	-------	21	
		5726	+57.0	226.1	+17.0	2424	-------	42	
		5727	+71.0	240.1	+13.0	194	3,623	1	
Jan. 23	11 13	5749	−72.0	84.0	+19.0	73	-------	3	Do.
		5744	−56.0	100.0	−7.0	24	-------	2	
		5740	−52.0	104.0	−13.0	24	-------	1	
		5748	−39.0	117.0	−18.0	16	-------	4	
		5743	−37.0	119.0	−8.0	36	-------	2	
		5736	−37.0	119.0	+21.0	194	-------	1	
		5747	−33.0	123.0	+31.0	36	-------	3	
		5739	+2.5	158.5	+11.0	121	-------	12	
		5734	+7.0	163.0	−20.0	97	-------	17	
		5741	+28.0	184.0	+7.0	24	-------	2	
		5733	+29.0	185.0	−10.0	242	-------	17	
		5726	+70.0	226.0	+17.0	1842	-------	32	
		5727	+86.0	242.0	+13.0	97	2,826	1	
Jan. 24	11 15	5749	−59.0	83.9	+19.0	48	-------	5	Do.
		5745	−47.0	95.9	−13.0	85	-------	8	
		5740	−39.0	103.9	−13.0	8	-------	1	
		5743	−23.0	119.9	−8.0	61	-------	8	
		5736	−23.0	119.9	+21.0	194	-------	1	
		5739	+17.0	155.9	+13.0	97	-------	10	
		5734	+19.5	162.4	−20.5	121	-------	15	
		5750	+41.0	183.9	−6.5	24	-------	4	
		5741	+42.0	184.9	+7.0	12	-------	1	
		5733	+42.0	184.9	−11.0	194	-------	14	
		5726	+82.0	224.9	+17.0	1067	1,911	8	
Jan. 25	11 21	5749	−49.0	80.6	+20.5	97	-------	6	Do.
		5752	−48.0	81.6	+28.0	24	-------	4	
		5745	−33.0	96.6	−13.0	48	-------	6	
		5740	−27.5	102.1	−14.0	97	-------	16	
		5751	−13.0	116.6	+15.0	24	-------	3	
		5736	−10.5	119.1	+21.0	206	-------	2	
		5739	+26.0	155.6	+14.0	24	-------	9	
		5739	+37.0	166.6	+12.0	97	-------	-------	
		5734	+32.0	161.6	−22.0	145	-------	12	
		5733	+54.0	183.6	−11.0	121	-------	7	
		5741	+56.0	185.6	+7.0	8	891	1	
Jan. 26	10 59	5749	−35.0	81.7	+20.0	145	-------	12	Do.
		5752	−33.0	83.7	+29.0	97	-------	13	
		5745	−18.0	98.7	−12.5	36	-------	6	
		5740	−13.0	103.7	−15.0	48	-------	3	
		5751	−1.0	115.7	+14.0	48	-------	4	
		5754	+2.0	118.7	+25.0	36	-------	4	
		5736	+2.0	118.7	+20.5	206	-------	2	
		5753	+7.0	123.7	+28.0	24	-------	1	
		5734	+46.0	162.7	−21.0	24	-------	4	
		5739	+49.0	165.7	+11.0	48	-------	12	
		5733	+69.0	185.7	−12.0	73	785	4	

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard time	Mt. Wilson group number	Heliographic: Diff. in longitude	Heliographic: Longitude	Heliographic: Latitude	Area: Spot or group	Area: Total for each day	Spot count	Observatory
1938	h. m.		°	°	°				
Jan. 27	11 6	5756	−79.0	24.4	+13.0	242	-------	9	U. S. Naval.
		5752	−23.0	80.4	+27.5	73	-------	5	
		5749	−21.5	81.9	+19.0	97	-------	5	
		5745	−7.0	96.4	−12.0	8	-------	2	
		5740	+2.0	105.4	−15.5	8	-------	1	
		5736	+13.5	116.9	+20.0	194	-------	1	
		5751	+13.5	116.9	+14.0	24	-------	3	
		5755	+25.0	128.4	+12.0	48	-------	6	
		5734	+59.0	162.4	−21.0	24	-------	4	
		5739	+64.0	167.4	+12.0	48	-------	6	
		5733	+80.0	183.4	−11.0	48	814	1	
Jan. 28	11 0	5758	−80.0	10.3	−5.0	48	-------	2	Do.
		5756	−65.0	25.3	+12.0	388	-------	17	
		5757	−1.0	89.3	+15.5	36	-------	4	
		5736	+27.5	117.8	+20.0	194	-------	1	
		5751	+27.5	117.8	+14.0	24	-------	4	
		5755	+38.0	128.3	+11.5	194	-------	15	
		5734	+70.0	160.3	−20.5	12	-------	1	
		5739	+78.0	168.3	+12.0	36	932	1	
Jan. 30	12 47	5760	−79.0	344.0	−11.0	48	-------	2	Do.
		5758	−53.0	10.0	−6.0	73	-------	8	
		5756	−36.0	27.0	+12.5	533	-------	16	
		5759	+7.0	70.0	+26.5	24	-------	3	
		5736	+54.0	117.0	+19.0	194	-------	1	
		5755	+65.0	128.0	+12.0	194	1,066	3	
Jan. 31	14 59	5760	−65.0	343.6	−11.0	97	-------	4	Do.
		5758	−34.0	14.6	−7.0	48	-------	4	
		5756	−24.0	24.6	+12.0	388	-------	1	
		5736	+69.0	117.6	+19.0	145	-------	3	
		5755	+78.0	126.6	+11.0	97	775	3	

Mean daily area for 27 days, 2,102.

NOTE.—Beginning with January 1938 spot counts are furnished with the regular sunspot data. Counts of spots or condensations are made from the original photographs for all regions of activity designated by Mount Wilson group numbers.

PROVISIONAL SUNSPOT RELATIVE NUMBERS FOR JANUARY 1938

[Dependent alone on observations at Zurich and its station at Arosa]

[Data furnished through the courtesy of Prof. W. Brunner, Eidgen. Sternwarte, Zurich Switzerland]

January 1938	Relative numbers	January 1938	Relative numbers	January 1938	Relative numbers
1	*a*	11	*ad* 98	21	*a*
2	*Ec* 109	12	*d*	22	122
3	*Wc* 86	13	106	23	-------
4	76	14	111	24	108
5	*d* 80	15	118	25	94
6	*a*	16	134	26	*a* 76
7	*Ec* 102	17	*b*	27	*Wcd* 67
8	-------	18	*b* 110	28	76
9	59	19	*Ec* 104	29	59
10	92	20	*Mc*	30	*d*
				31	76

Mean, 22 days = 93.8.

a = Passage of an average-sized group through the central meridian.
b = Passage of a large group or spot through the central meridian.
c = New formation of a group developing into a middle sized or large center of activity; *E:* on the eastern part of the sun's disc; *W:* on the western part; *M:* in the central circle zone.
d = Entrance of a large or average-sized center of activity on the east limb.

AEROLOGICAL OBSERVATIONS

[Aerological Division, D. M. LITTLE in Charge]

By L. P. HARRISON

Mean free-air data based on airplane weather and radiometeorograph observations during the month of January 1938, are given in table 1, which includes the basic elements, barometric pressure, temperature, and relative humidity at various standard geometric heights. Close approximation to the corresponding mean values of auxiliary data, such as equivalent potential temperature, mixing ratio, and potential temperature may be readily computed from these elements if desired. All "means" have been computed by the customary method of differences. "Means" have not been computed where there were less than 15 observations at the surface and less than 5 at the standard levels.

Readings of the hair hygrometric apparatus used as the basis for the relative humidities have been discarded when the air temperature has been lower than −40° C. and the air pressure at the same time has been less than 600 mb.

"Departures from normal" are not published here as in the past, owing to the shortness of the periods of record and the different periods over which the records extend.

For the first time in this summary, results of radiometeorograph observations are published, including those for two stations, viz: Boston, Mass., and Burbank, Calif.

Chart I indicates that the mean *surface* temperatures during January were above normal practically throughout the country. However, very slight negative departures from normal occurred over a relatively small area near the Great Lakes, as well as parts of the northeastern States and Florida.

Table 1 shows that the minimum mean free-air temperatures over the country occurred near the Great Lakes and to a lesser extent over the area immediately to the west.

The mean relative humidities over this region were high in comparison to those which prevailed to the south and southwest. In the stratum 2.5 to 5 km, the humidities over the central portion of the country appeared deficient with respect to the values obtaining over surrounding areas.

The isobaric charts constructed on the basis of the mean free-air barometric pressures for the month indicated the statistical center of minimum pressure over the country to be located near Sault Ste. Marie, Mich., or somewhat to the north. In the stratum 2.5 to 5 km, the mean isobaric configuration over the southern portion of the country was nearly symmetrical with the circles of latitude.

Table 2 shows the free-air resultant winds based on pilot-balloon observations made near 5 a. m. (75th meridian time) during January. The resultant wind directions were generally close to normal over the country with a few minor exceptions, viz: Key West, Fla., and some of the west coast stations. At the former place, the resultant directions were oriented from 55° to 105° clockwise from normal in the stratum 1 to 2 km, but the resultant velocities were slight (1.2 to 2.7 m. p. s.). At Medford, Oreg., the departures at 3 km appeared more significant: monthly resultant direction and velocity—233°, 9.0 m. p. s.; normal—282°, 5.0 m. p. s. At 1.5 km over Oakland, Calif., the resultant was oriented about 50° clockwise from normal, with slight velocity.

Departures of resultant velocity from normal were mostly within the range ±2 m. p. s., except at Key West (2.5 km, +3.0 m. p. s.), Sault Ste. Marie, Mich. (2.5 km, −4.3), Detroit, Mich. (2 km, −4.1; 2.5 km, −4.8) and Chicago, Ill. (1 km, −3.2).

Table 3 shows the maximum free-air wind velocities and their directions for various sections of the United States during January as determined by pilot balloon observations. The extreme maximum was 74.6 m. p. s. from the NNW at 4,590 m. above sea level over Abilene, Tex., on January 25th.

TABLE 1.—*Mean free-air, barometric pressures (P) in mb., temperatures (T) in °C., and relative humidities (R. H.) in percent, obtained by airplanes or radiometeorographs during January 1938*

Stations	Altitude (meters) m. s. l.																											
	Surface				500			1,000			1,500			2,000			2,500			3,000			4,000			5,000		
	Number of obs.	P	T	R. H.	P	T	R. H.	P	T	R. H.	P	T	R. H.	P	T	R. H.	P	T	R. H.	P	T	R. H.	P	T	R. H.	P	T	R. H.
Barksdale Field,[1] La. (52 m)	29	1,014	7.9	79	960	8.8	66	904	7.1	59	850	5.8	53	799	4.1	49	751	2.5	44	706	0.0	42	623	−5.6	32			
Billings, Mont.[2] (1,090 m)	31	891	−1.9	64							846	−0.6	54	795	−3.5	53	745	−6.3	55	699	−9.2	57	613	−15.5	55	536	−22.2	58
Boston, Mass.* (5 m)	28	1,017	−3.6	77	954	−5.5	82	896	−7.2	82	839	−7.9	80	788	−9.4	78	736	−10.9	79	691	−12.3	77	605	−17.4	74	528	−23.8	72
Burbank, Calif.* (220 m)	31	992	7.0	67	959	13.3	49	905	12.0	45	850	9.2	41	802	7.1	38	752	4.4	36	710	1.7	35	624	−4.9	35	548	−11.5	33
Cheyenne, Wyo.[2] (1,873 m)	30	809	−3.4	63										796	−1.6	58	747	−3.1	54	702	−6.3	54	615	−13.2	52	539	−19.6	50
Chicago, Ill.[2] (187 m)	31	993	−4.8	84	954	−5.7	83	895	−6.0	80	840	−6.6	75	788	−7.5	66	738	−8.8	54	662	−11.1	52	606	−15.5	49	531	−21.6	51
Coco Solo, C. Z.[3] (15 m)	30	1,009	24.7	86	955	22.8	88	902	19.7	84	851	16.8	77	802	14.3	72	755	12.6	52	712	10.8	36	630	5.4	24	557	0.3	22
El Paso, Tex.[2] (1,194 m)	31	884	4.6	63							851	6.5	48	801	4.4	49	752	2.2	47	707	−0.4	47	623	−6.0	40	548	−12.3	37
Fargo, N. Dak.[2] (274 m)	31	984	−15.1	79	955	−13.6	78	894	−10.5	74	838	−9.5	68	785	−10.3	63	735	−12.0	62	689	−13.8	62	603	−19.1	60	526	−25.0	60
Kelly Field, Tex.[1] (206 m)	18	996	8.7	80	961	12.0	59	905	11.0	51	852	9.5	46	802	7.4	39	754	5.0	36	709	2.0	34	625	−2.9	29	552	−10.1	25
Lakehurst, N. J.[3] (39 m)	20	1,014	−4.1	73	956	−3.0	61	897	−6.0	55	841	−6.3	52	790	−7.8	52	740	−9.4	47	694	−11.9	46	606	−18.1	44			
Maxwell Field, Ala.[1] (52 m)	23	1,015	7.2	71	961	6.1	67	904	4.2	60	850	2.8	50	799	1.1	48	750	−0.2	42	704	−2.0	39	620	−6.6	34	545	−12.3	30
Mitchel Field, N. Y.[1] (29 m)	25	1,016	−3.7	80	957	−3.3	70	898	−5.5	71	842	−6.8	66	790	−7.6	58	740	−8.4	54	694	−10.1	54	609	−14.7	52			
Nashville, Tenn.[2] (180 m)	31	998	2.3	81	959	2.3	74	901	1.0	69	846	−0.2	63	795	−1.2	58	746	−3.4	59	701	−5.9	58	615	−11.5	55	539	−18.2	55
Norfolk, Va.[3] (10 m)	15	1,020	0.3	67	959	−0.3	61	901	−1.8	55	846	−3.4	52	794	−4.0	50	744	−5.3	47	698	−6.9	47	613	−10.8	45	539	−16.0	47
Oakland, Calif.[3] (2 m)	31	1,021	8.0	85	962	10.2	63	906	9.4	53	852	7.7	50	802	5.4	43	753	2.6	41	708	−0.5	38	623	−7.4	38	548	−14.0	38
Oklahoma City,[2] Okla. (391 m)	31	972	2.2	72	960	3.8	65	903	4.9	55	848	3.9	51	797	1.5	51	749	−1.2	52	703	−3.5	47	618	−9.3	50	543	−15.4	46
Omaha, Nebr.[2] (300 m)	29	982	−6.1	81	957	−4.9	75	898	−2.8	64	844	−2.8	59	792	−4.1	53	742	−6.0	48	697	−8.6	48	611	−14.1	43	535	−21.2	42
Pearl Harbor, T. H.[3] (6 m)	31	1,016	20.2	81	960	20.2	72	905	16.7	79	853	14.5	72	804	13.5	51	757	12.0	34	712	9.5	30	631	3.5	26	557	−2.3	22
Pensacola, Fla.[3] (13 m)	21	1,022	8.3	81	963	8.3	70	906	7.5	64	852	6.2	55	802	5.1	50	753	3.8	41	708	2.0	32	625	−2.3	28	551	−7.8	27
Salt Lake City, Utah[2] (1,288 m)	31	875	−0.6	78							852	1.0	68	800	−0.8	64	751	−3.2	65	705	−5.4	62	619	−10.9	62	543	−17.2	62
San Diego, Calif.[3] (10 m)	31	1,018	9.1	82	960	14.0	63	904	11.8	53	851	9.7	45	801	7.2	43	753	4.6	39	708	1.8	38	624	−4.6	33	551	−12.4	31
Sault Ste. Marie, Mich.[2] (221 m)	29	989	−12.5	81	953	−12.7	79	893	−13.4	76	836	−14.2	71	782	−15.1	67	732	−16.8	66	685	−18.8	69	598	−22.7	67	521	−29.0	71
Scott Field, Ill.[1] (135 m)	17	1,005	−4.3	79	959	−3.4	69	900	−2.1	57	845	−3.1	54	793	−3.9	50	744	−5.5	49	698	−7.6	48	612	−12.9	45	537	−18.3	42
Seattle, Wash.[3] (10 m)	17	1,019	5.0	85	959	4.5	73	902	3.1	69	847	1.3	61	796	−1.3	59	747	−4.1	56	701	−7.0	46	616	−14.0	48			
Selfridge Field, Mich.[1] (177 m)	28	994	−6.3	81	954	−7.1	80	894	−8.2	78	839	−9.6	74	786	−10.2	69	736	−11.9	67	689	−13.7	63	603	−18.8	58	527	−25.1	55
Spokane, Wash.[2] (597 m)	31	951	−1.0	89				904	−2.4	88	849	−3.4	80	796	−3.6	70	747	−5.8	66	701	−8.6	63	614	−15.4	66	538	−21.8	63
Washington, D. C.[3] (13 m)	31	1,018	0.6	78	958	0.8	70	900	−0.7	66	845	−2.6	66	793	−4.2	64	744	−5.7	65	698	−7.6	62	612	−13.0	50	537	−19.5	48
Wright Field, Ohio[1] (244 m)	19	988	−3.4	84	956	−2.8	79	898	−4.0	77	843	−4.3	62	790	−5.2	52	741	−6.5	48	695	−8.3	42	610	−13.3	50	535	−19.6	56

		Altitude (meters) m. s. l.																										
		6,000			7,000			8,000			9,000			10,000			11,000			12,000			13,000			14,000		
		P	T	R. H.	P	T	R. H.	P	T	R. H.	P	T	R. H.	P	T	R. H.	P	T	R. H.	P	T	R. H.	P	T	R. H.	P	T	R. H.
Boston, Mass.	28	459	−30.5	71	399	−37.1	70	345	−44.2																			
Burbank, Calif.	31	481	−17.9	34	420	−24.5	34	366	−30.8	34	317	−36.9	33	274	−43.2		235	−48.8		202	−53.9							

[1] Army. [2] Weather Bureau. [3] Navy.

*Observations by radiometeorograph. Stations not so marked have observations by airplane. Number of observations at Boston at standard levels 6,000 m and higher were: 20, 14, and 8, respectively; at Burbank: 28, 25, 22, 20, 17, 12, and 8.

Observations taken about 4 a. m. 75th meridian time, except by Navy stations along the Pacific coast and Hawaii where they are taken at dawn.

TABLE 2.—*Free-air resultant winds (meters per second) based on pilot-balloon observations made near 5 a. m. (E. S. T.) during January 1938*

[Wind from N=360°, E=90°, etc.]

Altitude (meters) m. s. l.	Albuquerque, N. Mex. (1,554 m)		Atlanta, Ga. (309 m)		Billings, Mont. (1,088 m)		Boston, Mass. (15 m)		Cheyenne, Wyo. (1,873 m)		Chicago, Ill. (192 m)		Cincinnati, Ohio (153 m)		Detroit, Mich. (204 m)		Fargo, N. Dak. (283 m)		Houston, Tex. (21 m)		Key West, Fla. (11 m)		Medford, Oreg. (410 m)		Nashville, Tenn. (194 m)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°		°	
Surface	337	1.1	293	2.5	264	4.6	280	2.5	283	4.9	270	1.3	258	1.0	262	2.4	234	1.2	81	0.8	15	1.2	88	0.8	214	1.6
500			284	4.9			294	5.7			262	3.3	251	5.3	259	3.4	329	3.9	163	1.4	94	1.8	45	0.4	244	4.5
1,000			279	7.8			281	6.7			287	5.6	257	8.9	277	6.6	331	6.8	294	3.1	169	1.2	152	3.3	264	7.0
1,500			275	9.2	276	10.3	268	10.7			287	8.0	273	10.6	273	7.7	312	8.8	282	5.0	245	1.8	199	3.9	272	8.6
2,000	274	2.3	278	9.2	297	9.8	276	13.0	281	7.9	295	10.3	268	12.9	293	6.3	314	12.6	282	8.9	250	2.7	220	6.1	276	11.0
2,500	287	4.5	272	9.8	300	10.3	277	14.9	292	12.6	298	12.3	269	9.3	292	7.2	314	14.6	291	8.6	251	5.0	236	7.0	286	14.0
3,000	296	7.5	276	13.1	303	11.8	291	13.0	305	11.4							313	14.2	284	9.2	236	4.7	233	9.0		
4,000	302	12.1			303	11.2			305	11.5									276	9.5						
5,000	300	9.7																	271	12.2						

Altitude (meters) m. s. l.	Newark, N. J. (14 m)		Oakland, Calif. (8 m)		Oklahoma City, Okla. (402 m)		Omaha, Nebr. (306 m)		Pearl Harbor, Territory of Hawaii[1] (68 m)		Pensacola, Fla.[1] (24 m)		St. Louis, Mo. (170 m)		Salt Lake City, Utah (1,294 m)		San Diego, Calif. (15 m)		Sault Ste. Marie, Mich. (198 m)		Seattle, Wash. (14 m)		Spokane, Wash. (603 m)		Washington, D. C. (10 m)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°		°	
Surface	295	1.8	104	0.5	327	1.1	332	1.4	44	3.3	353	1.9	258	2.8	152	1.8	22	0.8	88	0.8	147	1.9	196	0.7	296	0.7
500	283	5.1	51	2.1	276	1.1	284	2.9	75	5.3	293	1.5	270	7.5			21	0.6	127	1.2	187	3.5			272	4.9
1,000	279	8.2	25	3.2	281	6.2	277	8.4	82	5.6	274	6.1	285	11.9			16	1.5	299	4.9	208	4.5	177	1.4	277	7.8
1,500	253	11.0	19	1.5	288	7.8	287	10.5	86	4.2	272	7.1	289	12.5	168	2.2	353	2.0	297	4.3	221	4.3	225	3.5	277	8.5
2,000	262	12.3	347	2.0	286	8.2	288	12.0	65	3.2	273	8.3	295	13.4	224	2.8	352	3.3	292	6.1	227	6.7	258	4.1	271	9.9
2,500	271	10.9	350	2.9	292	11.3	292	12.1	62	3.2	270	11.7	289	14.2	274	3.8	339	4.1	290	5.4	246	7.5	285	6.0	263	13.6
3,000			334	3.3	282	11.9	296	13.6	45	3.2	271	14.2	292	14.5	287	4.5	333	4.2					297	7.0	268	15.3
4,000			311	4.6					22	4.3			287	16.7	302	9.9	357	6.9					261	10.6		
5,000									3	2.4																

[1] Navy stations.

TABLE 3.—*Maximum free-air wind velocities (meters per second) for different sections of the United States, based on pilot-balloon observations during January 1938*

Section	Surface to 2,500 meters (m. s. l.)					Between 2,500 and 5,000 meters (m. s. l.)					Above 5,000 meters (m. s. l.)				
	Maximum velocity	Direction	Altitude (m), m. s. l.	Date	Station	Maximum velocity	Direction	Altitude (m), m. s. l.	Date	Station	Maximum velocity	Direction	Altitude (m), m. s. l.	Date	Station
Northeast[1]	50.1	SSW	1,240	24	Cleveland	37.1	NNW	4,300	28	Cleveland	43.2	W	6,280	20	Cleveland.
East Central[2]	39.0	SW	1,650	30	Knoxville	38.4	NW	4,320	28	Greensboro	44.0	W	9,030	5	Knoxville.
Southeast[3]	38.2	WSW	2,080	25	Jacksonville	37.8	W	2,980	26	Jacksonville	34.4	W	6,780	5	Charleston.
North Central[4]	38.4	S	1,190	24	Detroit	40.3	NW	5,000	22	Minneapolis	46.7	NW	5,830	22	Bismarck.
Central[5]	37.2	SW	1,050	29	Indianapolis	45.4	NNW	4,720	27	Omaha	51.2	NNW	6,160	14	Omaha.
South Central[6]	49.6	SW	1,930	28	Oklahoma City	74.6	NNW	4,590	25	Abilene	38.0	NW	8,750	2	Houston.
Northwest[7]	34.9	SSW	1,550	31	Portland	55.8	S	2,840	30	Medford	53.6	NNW	5,410	11	Missoula.
West Central[8]	36.6	WNW	2,090	10	Cheyenne	50.3	NW	5,000	23	Modena	73.6	NW	7,000	23	Modena.
Southwest[9]	28.8	SSE	2,500	14	San Diego	59.0	NNW	4,160	25	Albuquerque	53.0	WNW	6,140	17	Albuquerque.

[1] Maine, Vermont, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, and northern Ohio.
[2] Delaware, Maryland, Virginia, West Virginia, southern Ohio, Kentucky, eastern Tennessee, and North Carolina.
[3] South Carolina, Georgia, Florida, and Alabama.
[4] Michigan, Wisconsin, Minnesota, North Dakota, and South Dakota.
[5] Indiana, Illinois, Iowa, Nebraska, Kansas, and Missouri.
[6] Mississippi, Arkansas, Louisiana, Oklahoma, Texas (except El Paso), and western Tennessee.
[7] Montana, Idaho, Washington, and Oregon.
[8] Wyoming, Colorado, Utah, northern Nevada, and northern California.
[9] Southern California, southern Nevada, Arizona, New Mexico, and extreme west Texas.

RIVERS AND FLOODS

[River and Flood Division, Merrill Bernard in Charge]

By Bennett Swenson

The principal floods during January 1938 occurred as a result of a prolonged period of heavy precipitation from about the 20th–25th over an extensive area. The center of heaviest precipitation during this period was located over Arkansas and western Tennessee; and from this point the precipitation area extended to eastern and central Texas, to Illinois and Wisconsin, and to New England, with light to moderate floods in much of this area. Additional rains at the close of the month from central Kentucky to Louisiana, and in the Rock River basin in Illinois, prolonged the floods in those sections, with the flood period extending into February in most cases.

Abundant precipitation occurred also in the North Pacific slope area following the above-normal rainfall in that section in December. However, moderate flooding resulted only in the Willamette River basin in Oregon, causing no serious damage.

Other regions visited by floods were portions of the Roanoke, Cape Fear, and Santee Rivers in North and South Carolina and the Tombigbee and Pearl Rivers in Alabama and Mississippi. These floods were of minor character, and no appreciable amount of damage occurred.

Atlantic Slope drainage.—A flood occurred in the Connecticut Valley and was caused by mild temperature and moderate to heavy rain on the night of January 24–25, falling on an above average snow cover. In Connecticut and parts of Massachusetts the 10- to 15-inch snow cover entirely disappeared over night. The rain and melting snow resulted in higher stages in many of the headwaters of the tributary streams than those of the all-time high stages of March 1936. The Connecticut River, however, was rising from low stages and did not exceed flood stage at any of the regular reporting stations except Hartford, Conn. The crest at that point was 19.6 feet on January 26, 3.6 feet above flood stage. No damage of consequence was reported.

Similar conditions over the headwaters of the Susquehanna River basin resulted in floods over portions of the Chenango and Tioughnioga Rivers in New York; and the Susquehanna River exceeded flood stage at Oneonta and Bainbridge, N. Y., on the 25th–26th. The stages were not high, however, and little damage occurred, being confined mostly to delays and inconvenience to road traffic.

Upper Mississippi Basin.—A well-developed low-pressure area, moving from the southwest, was located over central Illinois on the morning of January 24. Heavy rains and mild temperatures, accompanying this disturbance, melted the snow cover; and the combined run-off filled the streams in Illinois and southern Wisconsin, and caused a breaking up of the ice. Considerable flooding resulted principally in the Rock River in Illinois and Wisconsin. A second disturbance over the same area, on the night of the 29th, accompanied by another period of moderately heavy rain and mild temperature, caused further high stages in that stream which continued into February. A more complete report of this flood will be given in the next issue of the Review.

Flooding also occurred in the Illinois River, with flood stages being exceeded at Peru and Havana, Ill. The overflow in this case was not great and no damage of consequence was reported.

Lower Mississippi drainage.—Portions of the St. Francis, Yazoo, White, Arkansas, and Red Basins experienced floods during the latter part of the month because of almost continuous heavy rain over much of that section from January 20–25. Of the regular Weather Bureau stations, Little Rock, Ark., reported the greatest 24-hour amount, 4.62 inches on the morning of January 21, followed by 2.76 inches in the next 24 hours. Moderately heavy rains occurred again in this section on the 30th–31st and prolonged the flood in some parts.

The highest stages occurred in the Ouachita River at Camden, Ark., where a stage of 40.7 feet (flood stage 26 feet) was reached on January 27. A total damage estimated at about $28,000, occurred.

The Cypress and Sulphur Rivers in Texas and the Little River in Arkansas, all tributaries of the Red River, and the lower portion of the Red proper, were in flood the latter part of the month. The before-mentioned tributaries were also in flood at the beginning of January.

Floods in the Red, Arkansas, White, Yazoo, and St. Francis Basins continued, for the most part, into February; and in some cases, exceeded the stages reached in January. Consequently, a final report will have to be given at a later date.

The estimated damages in the Red River Basin during the month are as follows: Red River above Shreveport, La., $60,450; Sulphur River below Ringo Crossing, Tex., $39,500; Cypress River in vicinity of Jefferson, Tex., $8,150; and Little River, $1,610.

West Gulf of Mexico drainage.—Heavy rain over most of eastern Texas, January 21–23, caused sharp rises principally in the Trinity, Brazos, and Guadalupe Rivers. The floods were localized due to the local character of the excessive rains. More damage probably resulted from the excessive rains than from the floods. Dallas, Tex., reported 3.08 inches of rain in 24 hours on the morning of the 22d and 1.36 inches in the following 24 hours.

The Trinity River reached a stage of 36.5 feet at Dallas on January 24, 8.5 feet above flood stage, and 39.8 feet at Trinidad, Tex., on January 29, 11.8 feet above flood stage. However, the West Fork of the Trinity at Fort Worth, Tex., did not reach flood stage. The total estimated loss in the Trinity River Basin was about $60,000, most of which occurred in the vicinity of Fort Worth, Tex.

The Brazos River exceeded flood stage by 3 feet at Waco, Tex., on January 24, with estimated damage amounting to about $10,000.

A small flood occurred in the Guadalupe River, exceeding flood stage at Gonzales and Victoria, Tex. No losses of consequence were reported.

A report, received too late for inclusion in the December issue of the Review, indicates that Kings River, in the San Joaquin River Basin, reached the highest stage of record at Piedra, Calif., 20.05 feet on December 11. Damages are estimated as follows: Roads and bridges, $139,850; weirs and levees, $102,000; railroads, $27,800.

Another report, concerning the flood in the Wabash-White River in December gives an estimated loss of about $7,000, mostly confined to the White River.

Table of flood stages during January 1938

[All dates in January unless otherwise specified]

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
ATLANTIC SLOPE DRAINAGE	*Feet*			*Feet*	
Connecticut: Hartford, Conn	16	26	28	19.6	26
Schuylkill: Reading, Pa	7	25	26	8.0	25
Tioughnioga: Whitney Point, N. Y	12	25	26	13.2	25
Chenango:					
Sherburne, N. Y	8	25	25	8.0	25
Greene, N. Y	8	26	26	8.0	26
Susquehanna:					
Oneonta, N. Y	12	25	27	15.2	25
Bainbridge, N. Y	12	25	26	12.9	26
James: Columbia, Va	10	26	28	12.4	27
Roanoke: Williamston, N. C	10	12	16	10.2	13, 14
		30	(1)	10.2	31
Cape Fear: Elizabethtown, N. C	20	9	9	20.8	9
Santee:					
Rimini, S. C	12	Dec. 30	1	12.8	Dec. 31
		6	9	12.5	8
		12	15	12.6	13
		20	22	12.5	21
		28	29	12.2	28
Ferguson, S. C	12	1	1	12.0	1
		14	15	12.1	15
		22	22	12.0	22
EAST GULF OF MEXICO DRAINAGE					
Tombigbee: Lock No. 3	33	2	7	35.9	5
Pearl: Jackson, Miss	18	2	13	21.2	8
MISSISSIPPI SYSTEM					
Upper Mississippi Basin					
Rock: Moline, Ill	10	25	(1)	13.8	30
Illinois:					
Peru, Ill	17	25	25	18.1	25
		31	31	17.0	31
Havana, Ill	14	30	(1)	15.0	Feb. 1
Ohio Basin					
West Fork of White: Anderson, Ind	8	1	3	8.4	2
		25	26	8.1	26
Cumberland:					
Celina, Tenn	28	24	26	29.8	25
Lock No. 6	35	25	27	35.8	26
Tennessee: Hales Bar Lock, Tenn. (upper gage)	44	27	27	44.1	27
White Basin					
White:					
Batesville, Ark	23	25	26	23.3	25
Georgetown, Ark	21	30	Feb. 7	22.3	Feb. 2
Clarendon, Ark	26	29	Feb. 13	27.7	Feb. 7
St. Charles, Ark	24	29	(1)	25.9	Feb. 8–10

[1] Continued at end of month.

Table of flood stages during January 1938—Continued

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
Arkansas Basin	*Feet*			*Feet*	
Poteau: Poteau, Okla	21	22	28	31.7	25
Petit Jean: Danville, Ark	20	22	29	27.1	25
		31	(1)		
Red Basin					
Little Missouri: Boughton, Ark	20	23	27	22.9	25
Ouachita:					
Arkadelphia, Ark	17	22	27	26.0	24
Camden, Ark	26	23	Feb. 6	40.7	27
Little: Whitecliffs, Ark	25	24	(1)	31.0	26
Sulphur:					
Ringo Crossing, Tex	20	1	1	21.8	1
		21	28	32.0	24
		31	(1)	...	...
Naples, Tex	22	Dec. 22	8	27.7	Dec. 31
		23	(1)	35.0	25
Cypress: Jefferson, Tex	18	Dec. 30	5	23.6	1
		26	(1)	25.7	27
Red:					
Index, Ark	25	25	27	25.8	26
Fulton, Ark	25	24	(1)	32.9	28
Grand Ecore, La	33	31	(1)	...	...
Alexandria, La	32	30	(1)	...	...
Lower Mississippi Basin					
Big Lake Outlet: Manila, Ark	10	Dec. 30	5	10.4	1, 2
		26	(1)	...	...
St. Francis:					
Fisk, Mo	20	25	28	22.8	26
St. Francis, Ark	18	29	(1)	...	...
Tallahatchie: Swan Lake, Miss	26	28	(1)	...	...
WEST GULF OF MEXICO DRAINAGE					
Sabine: Logansport, La	25	13	21	27.3	17
Elm Fork: Carrollton, Tex	6	23	25	8.1	24
Trinity:					
Dallas, Tex	28	22	26	36.5	24
Trinidad, Tex	28	Dec. 29	3	31.0	1
		23	(1)	39.8	29
Long Lake, Tex	40	5	6	40.1	5
		27	(1)	45.0	29
Liberty, Tex	24	12	14	24.6	13
Grazos: Waco, Tex	27	24	24	30.2	24
Buadalupe:					
Gonzales, Tex	20	24	26	27.6	25
Victoria, Tex	21	27	28	22.7	28
PACIFIC SLOPE DRAINAGE					
Columbia Basin					
Santiam: Jefferson, Oreg	10	22	23	14.5	22
Willamette:					
Harrisburg, Oreg	10	22	24	13.0	23
Oregon City, Oreg	12	Dec. 29	3	16.3	Dec. 31

[1] Continued at end of month.

WEATHER ON THE ATLANTIC AND PACIFIC OCEANS

[The Marine Division, I. R. TANNEHILL in Charge]

NORTH ATLANTIC OCEAN, JANUARY 1938

By H. C. HUNTER

Atmospheric pressure.—The North Atlantic HIGH and the Icelandic LOW were both unusually well developed during the month. The latter was more intense than usual practically all the time after the first week, and was displaced somewhat to eastward of its average position. The pressures for the month averaged about 0.3 inch less than normal at Reykjavik and at Lerwick.

The North Atlantic HIGH similarly was displaced considerably to eastward. The greatest average excess of pressure, 0.16 inch, is noted at Madeira, though at Horta the average pressure was slightly higher than at Madeira. This HIGH was best developed from the 21st to the end of the month.

Near the American coast, from Labrador to Maine and to eastward beyond the Grand Banks, there was a moderate excess of pressure; while from the vicinity of Cape Cod to the straits of Florida and to eastward far beyond Bermuda the pressure averaged somewhat less than normal.

The extreme pressure readings in the January vessel reports now available are 30.85 and 28.02 inches. The higher reading was observed on the French motor vessel *Pierre L. D.* when in approximately 43° N., 25° W., during the forenoon of the 27th. The lower reading has come from the American steamer *Cliffwood,* which noted it early on the 13th, near 60° N., 12° W. The meteorological station at Lerwick, Shetland Islands, had the same sea-level pressure on the 29th, as table 1 indicates.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure (sea level) at selected stations for the North Atlantic Ocean and its shores, January 1938*

Stations	Average pressure	Departure	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Julianehaab, Greenland	29.28	−0.15	29.96	6	28.56	19
Reykjavik, Iceland	29.20	−.26	30.18	6	28.26	28
Lerwick, Shetland Islands	29.38	−.32	30.56	3	28.02	29
Valencia, Ireland	29.89	−.01	30.65	1	28.82	9
Lisbon, Portugal	30.27	+.12	30.59	25	29.80	14
Madeira	30.26	+.16	30.51	29	29.95	2
Horta, Azores	30.29	+.13	30.80	27, 28	29.80	15
Belle Isle, Newfoundland	29.87	+.13	30.46	2	29.30	19
Halifax, Nova Scotia	30.07	+.09	30.58	30	29.58	13
Nantucket	30.03	−.01	30.44	30	29.41	13
Hatteras	30.08	−.06	30.55	29	29.38	25
Bermuda	30.07	−.09	30.54	30	29.66	13
Turks Island	30.08	+.03	30.19	30	29.95	5
Key West	30.09	−.01	30.49	28	29.88	6
New Orleans	30.13	.00	30.58	28	29.72	24

NOTE.—All data based on a. m. observations only, with departures compiled from best available normals related to time of observation, except Hatteras, Key West, Nantucket, and New Orleans, which are 24-hour corrected means.

Cyclones and gales.—With the great Atlantic "centers of action" intensified during most of January, an unusually stormy month naturally resulted. The information available indicates this to be the stormiest, yet, of the present cold season months. Three reports of force-12 winds are at hand and 13 of force-11 winds. The period from 12th to 18th was very stormy and the final few days were stormy over the waters near the British Isles.

An unusual report for the winter season and the latitude of the Tropic of Cancer is that of the *Cathlamet*, which encountered hurricane winds near the forty-first meridian during the night of the 4th–5th. Pressure below 29.5 inches was recorded by this vessel, but the area of low pressure was apparently small. A strong anticyclone was almost directly north of the position, central about 700 miles west of Horta.

Chart IX presents the situation on the 14th, when a large low-pressure system covered the northeast Atlantic. At this time a feature of much importance to the eastern parts of the steamship lanes was the LOW which was near the Azores on the 13th, and advanced to the British Isles on the 15th. The American steamer *Independence Hall* noted force-12 winds, and winds of nearly that strength were encountered by other vessels in the eastern North Atlantic. The British coastwise freighter *Glanrhyd* was apparently lost with all the crew of 22; and other vessels in British waters lost several men in the aggregate.

At the same time a severe storm was traversing the West Atlantic, from near Cape Hatteras on the evening of the 12th to a position 300 miles south of Cape Race on the morning of the 14th. The *Steel Traveler*, from the Mediterranean to Boston, met force-12 wind near the fifty-fourth meridian on the 14th; and many other vessels reported severe encounters. The American steamer *Effingham* and the Greek *Aspasia* each lost two men overboard, and each turned from its course to make port for repairs—Bermuda and San Miguel, respectively. From the position to southward of Newfoundland this LOW continued eastward, with gradual decrease in energy.

About 2 days behind the LOW just mentioned another energetic LOW followed nearly the same path till near the Grand Banks, when it turned to a more northerly course and so had little effect on the chief steamship routes to eastward of the thirty-fifth meridian. Chart X indicates the conditions on the 16th.

Another storm of importance was centered over the lower Mississippi Valley late on the 23d, advancing toward the northeast. Several vessels in the northern Gulf of Mexico or near the coast of the South Atlantic States met intense winds in connection with this LOW, which was followed by a well-developed HIGH, that covered the northwestern Gulf on the 26th and 27th. Unusually strong winds from a northerly quarter were felt in thet western Caribbean Sea about the 26th, where at least five lives were lost in the wrecking of comparatively small vessels.

A large-area LOW of great energy affected the region from near Iceland to the coast of Norway from the 27th to the 30th. In connection with the very high pressure near the Azores and Portugal at this time, the LOW brought a second period of very stormy weather to the waters around the British Isles. Winds of force 11 were met in the English Channel, and the waters around Scotland probably had gales of at least equal strength. Chart XI indicates the situation of the 28th.

Fog.—For the most part, fog was even more infrequent than usual in January. However, one square in the Gulf of Mexico, 25° to 30° N., 90° to 95° W., as in December 1937, reported fog on 7 days, all within the period from the 12th to the 23d, inclusive. A very few scattered reports of fog were received from other northern portions of the Gulf of Mexico and from waters just east of the South Atlantic States.

From Hatteras to the Grand Banks fog was decidedly rare, but almost every 5°-square reported slight amounts, and two squares of the southern Grand Banks area furnished reports of 4 days each. From the eastern Banks to the vicinity of the British Isles there was no fog reported, but to eastward and northeastward of the Azores there was a little, all occurrences here being within the period 11th to 26th, inclusive.

OCEAN GALES AND STORMS, JANUARY 1938

Vessel	Voyage: From—	Voyage: To—	Position at time of lowest barometer: Latitude	Position at time of lowest barometer: Longitude	Gale began January—	Time of lowest barometer January—	Gale ended January—	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
NORTH ATLANTIC OCEAN			° ′	° ′				Inches					
Bonneville, Nor. M. S.	Baltimore	Glasgow	[3]48 03 N.	40 43 W.	1	8p, 1	2	29.56	SW	SW, 10	WSW	W, 11	SW-W.
Scanstates, Am. S. S.	Copenhagen	New York	51 45 N.	42 50 W.	1	9p, 1	2	29.09	NW	Calm	W	NW, 10	SSW-Calm-NW.
Crijnssen, Du. S. S.	Dover	Barbados	[3]31 01 N.	37 27 W.	2	2a, 2	2	29.72		WSW, 7		WNW, 9	SW-W.
Cathlamet, Am. S. S.	St. Vincent, C. V. I.	New York	23 42 N.	41 00 W.	3	10p, 4	6	29.44	ENE	NE, 10	ENE	NE, 12	NNE-ENE.
City of Norfolk, Am. S. S.	Southampton	Norfolk	49 55 N.	20 28 W.	8	Noon, 8	9	29.35	W	NW, 7	WNW	WNW, 10	SW-NW.
Nemaha, Am. S. S.	Beaumont	Avonmouth	50 12 N.	8 30 W.	9	6p, 9	10	28.93	W	W, 9	NW	NW, 10	W-N.
Cliffwood, Am. S. S.	Copenhagen	Wilmington, Del.	59 30 N.	11 40 W.	11	4a, 13	14	28.02	WSW	W, 11	W	W, 11	S-W.
Monarch of Bermuda, Br. S. S.	Bermuda	New York	[3]35 55 N.	68 37 W.	13	9a, 13	13	29.18	W	W, 7	NNW	NW, 9	SSW-NW.
Belgian Gulf, Belg. M. S.	Texas City	Copenhagen	[3]38 55 N.	61 14 W.	13	11p, 13	14	28.53	W	NW, 10	NW	NW, 10	W-NW.
Steel Traveler, Am. S. S.	Gibraltar	Boston	37 18 N.	54 05 W.	13	6a, 14	14	28.70	ESE	W, 12	NW	W, 12	
Independence Hall, Am. S. S.	Havre	New York	49 35 N.	19 38 W.	14	7a, 14	15	28.27	NW	NW, 12	SW	NW, 12	None.
Warrior, Am. S. S.	Mobile	London	[3]41 37 N.	53 50 W.	13	7a, 14	15	28.54	ESE	SE, 6	NNW	ESE, 11	SW-SE-NW.
Ary Lensen, Br. M. S.	Ghent	Newport News	46 00 N.	10 00 W.	14	11a, 14	14	29.62	SW	SW, 10	W	SW, 11	W-SW.
Armadale, Br. M. S.	Hull	New York	[3]42 26 N.	52 16 W.	14	1p, 14	14	28.70	E	NE, 2	N	N, 11	ESE-NNE.
Lafayette, Fr. M. S.	Southampton	do	50 22 N.	15 30 W.	14	4p, 14	15	28.37	WSW	WSW, 7	WNW	WNW, 10	SSW-WNW.
Bienville, Am. S. S.	Glasgow	Mobile	53 20 N.	14 30 W.	14	6p, 14	15	28.28	N	E, 3	WNW	NNW, 11	E-W.
Exochorda, Am. S. S.	Gibraltar	Boston	40 02 N.	41 35 W.	14	10p, 14	15	29.04	SSW	SW, 8	NW	SW, 9	SW-W.
Vincent, Am. S. S.	New York	Havre	[3]45 15 N.	42 26 W.	14	3a, 15	15	28.63	SE	E, 2	NNW	ESE, 10	S-NE.
Medea, Du. S. S.	Inagua	New York	32 39 N.	74 00 W.	14	3a, 15	15	29.75	WSW	NW, 8	NW	W, 9	W-NW.
West Kyska, Am. S. S.	Mobile	Bremen	47 09 N.	32 59 W.	14	Noon, 15	16	28.77	ESE	S, 5	NNE	NNE, 10	ESE-S-NNE.
Camito, Br. S. S.	Avonmouth	Kingston	40 35 N.	30 30 W.	15	4p, 15	16	29.48	SSW	SW, 9	NNW	W, 11	SSW-W.
Exochorda, Am. S. S.	Gibraltar	Boston	41 13 N.	50 31 W.	16	8a, 16	16	29.08	SW	SW, 7	NW	W, 9	S-WSW.
Warrior, Am. S. S.	Mobile	London	43 56 N.	44 24 W.	16	Noon, 16	18	29.12	SSE	SSW, 10	WNW	SW, 10	SSE-SW.
Maasdam, Du. S. S.	Rotterdam	Philadelphia	47 11 N.	41 04 W.	16	5a, 17	17	28.96	S	WSW, 8	WNW	S, 10	SW-W.
American Shipper, Am. S. S.	Liverpool	New York	[3]46 25 N.	40 32 W.	16	10a, 17	18	[2]29.20	S	WSW, 9	W	S, 11	SW-WNW.
Scanyork, Am. S. S.	Stockholm	do	56 48 N.	22 18 W.	17	2a, 18	20	28.74	S	W, 6	SW	SW, 11	SSW-W.
American Shipper, Am. S. S.	Liverpool	do	[3]46 11 N.	45 36 W.	18	2p, 18	19	[2]28.97	SSE	SSW, 10	WNW	S, 11	SSE-S-WNW.
Warrior, Am. S. S.	Mobile	London	[3]47 07 N.	33 22 W.	18	Mdt, 18	19	29.38	S	SSW, 9	SW	SSW, 10	
Knoxville City, Am. S. S.	Gibraltar	Savannah	32 00 N.	53 10 W.	19	4a, 20	20	29.53	SW	SW, 7	NW	NNW, 11	SW-WNW.
Saleier, Du. S. S.	Dakar	Halifax	31 08 N.	54 18 W.	19	8a, 20	20	29.59	SW	W, 6	NNW	NNE, 10	SSW-W-NNE.
Scottish Musician, Br. M. S.	Houston	Hamburg	37 24 N.	36 45 W.	19	6a, 21	21	29.23	SW	S, 10	W	S, 10	S-WSW.
Black Hawk, Am. S. S.	Antwerp	New York	[3]49 28 N.	29 42 W.	21	6a, 22	22	28.50	SSE	W, 10	W	S, 10	S-W.
Saleier, Du. S. S.	Dakar	Halifax	36 33 N.	61 36 W.	22	2p, 22	22	29.62	SW	WNW, 9	NNE	WSW, 10	WSW-WNW.
Exmoor, Am. S. S.	New York	Gibraltar	39 19 N.	37 00 W.	23	10a, 23	24	29.95	SW	SSW, 8	SSW	SSW, 10	None.
Saleier, Du. S. S.	Dakar	Halifax	40 23 N.	62 42 W.	23	2p, 23	23	29.74	E	ENE, 10	NNE	NE, 10	E-NE.
Skramstad, Nor. M. S.	Gibraltar	New York	[3]33 46 N.	62 51 W.	23	4p, 23	24	29.71	NNW	NNW, 7	NNW	NNW, 10	SW-NNW.
New York, Ger. S. S.	Cherbourg	do	49 05 N.	25 39 W.	23	6a, 24	24	29.25	SW	S, 10	NNW	WSW, 11	S-SW.
Brasilien, Dan. S. S.	Copenhagen	Galveston	26 27 N.	88 00 W.	25	6a, 24	25	29.83		WSW, 4		NNW, 8	
Carare, Br. S. S.	Kingston	Avonmouth	37 16 N.	52 12 W.	23	1p, 24	25	29.35	E	NE, 10	ENE	NE, 10	ESE-NE.
Sunbeam, Am. S. S.	Carteret, N. J.	Corpus Christi	35 05 N.	74 46 W.	24	5a, 25	26	29.60	SE	SE, 10	W	SE, 10	SE-WSW.
Mobile City, Am. S. S.	Oran	Baltimore	35 30 N.	50 12 W.	23	8a, 25	25	29.52	SW	N, 8	N	N, 10	SW-N.
California, Am. S. S.	Cristobal	Havana	9 25 N.	79 52 W.	25	4p, 25	29	29.86	N	N, 3	ESE	NNE, 7	NE-N.
Southern Prince, Br. M. S.	Trinidad	New York	19 02 N.	64 00 W.	29	4a, 30	31	30.00	NE	NE, 7	E	NE, 7	None.
Steel Worker, Am. S. S.	Liverpool	Baltimore	[3]50 04 N.	38 38 W.	30	4a, 30	31	29.40	SW	SSW, 9	WNW	W, 10	SSW-W.
Scottish Musician, Br. M. S.	Houston	Hamburg	50 14 N.	2 05 W.	27	5a, 30	30	29.27	NW	W, 11	NW	W, 11	W-NW.
NORTH PACIFIC OCEAN													
Pres. McKinley, Am. S. S.	Yokohama	San Francisco	47 44 N.	172 10 W.	[1]31	2 a, 1	1	29.13	W	W, 9	W	W, 9	
Scottsburg, Am. S. S.	Cebu, P. I.	Los Angeles	40 55 N.	145 29 W.	1	3 p, 2	2	29.38	S	SW, 7	SW	S, 9	
Koyo Maru, Jap. S. S.	Yokohama	Port San Luis	39 00 N.	165 18 W.	1	1 a, 2	2	29.38	W	W, 8	W	W, 9	SE-W.
W. S. Miller, Am. S. S.	Los Angeles	Vladivostok	34 30 N.	165 30 E.	2	5 p, 2	2	29.23	S	SSW, 9	W	WSW, 9	SSW-WSW.
San Pedro Maru, Jap. MS.	Port Costa	Yokohama	33 56 N.	144 55 E.	2	2 a, 3	3	29.53	W	W, 11	WNW	W, 12	
Empress of Canada, Br. S. S.	Yokohama	Honolulu	33 48 N.	163 00 E.	1	3 p, 2	3	29.22	S	SSW, 10	NW	SSW, 10	SSW-WSW.
Ixion, Br. S. S.	Nagoya	Vancouver, B. C.	42 13 N.	153 52 E.	3	1 p, 3	3	28.91	ESE	S, 4	SW	SE, 9	E-SW.
Hoyo Maru, Jap. M. S.	Port San Luis	Tokuyama	32 14 N.	160 28 W.	3	Noon, 3	3	29.60	SSW	WSW, 10	W	WSW, 10	SSW-W.
Pleasantville, Nor. M. S.	Hong Kong	Los Angeles	40 00 N.	159 54 E.	3	10 p, 4	4	29.22	WSW	W, 8	W	W, 9	W-WNW.
Saparoea, Du. M. S.	Manila	Portland, Oreg.	38 40 N.	163 40 E.	3	7 a, 5	5	29.32	SW	W, 9	W	W, 10	W-WNW.
Silverbelle, Br. M. S.	Tandoc, P. I.	Los Angeles	37 07 N.	164 36 E.	5	8 a, 5	5	[2]29.35	NNW	W, 12	WNW	W, 12	NNW-W.
Hoegh Hood, Nor. M. S.	Yokohama	do	42 30 N.	178 30 E.	5	Mdt, 5	5	28.75	W	W, 5	W	W, 8	
Saparoea, Du. M. S.	Manila	Portland, Oreg.	38 43 N.	171 06 E.	6	Noon, 6	7	29.34	W	W, 6	NNW	WNW, 8	W-NNW.
Do	do	do	44 04 N.	170 44 W.	8	2 p, 9	10	28.69	ESE	SSW, 8	SSW	SE, 12	S-SW.
Texas, Am. S. S.	Cebu, P. I.	San Francisco	38 06 N.	172 20 E.	8	3 p, 9	10	28.72	S	W, 12	WNW	W, 12	None.
Pleasantville, Nor. M. S.	Hong Kong	Los Angeles	[3]41 21 N.	168 28 W.	8	10 a, 9	9	29.00	SE	S, 7	S	SSE, 9	SSE-SSW.
Silverbelle, Br. M. S.	Tandoc, P. I.	do	40 05 N.	162 25 W.	9	5 p, 9	9	[2]29.04	SE	SSE, 8	S	SSE, 9	SE-S.
Asaka, Maru Jap. M. S.	Yokohama	do	44 50 N.	151 47 W.	9	10 p, 9	9	29.27	ENE	S, 7	E	ENE, 9	ESE-SSW.
Ixion, Br. S. S.	Nagoya	Vancouver, B. C.	50 09 N.	159 46 W.	9	6 a, 10	10	28.74	SE	S, 5	S	E, 10	E-S-ESE.
Pres. Jefferson, Am. S. S.	Victoria, B. C.	Yokohama	46 06 N.	159 14 E.	11	Noon, 11	11	29.50	NW	NW, 7	NW	NW, 9	None.
San Diego Maru, Jap. M. S.	Yokohama	Los Angeles	40 17 N.	158 55 W.	11	8 p, 11	12	28.86	SE	SSW, 8	SW	SW, 9	E-SSW-W.
Saparoea, Du. M. S.	Manila	Portland, Oreg.	45 02 N.	156 00 W.	11	5 a, 12	12	28.51	ESE	Var, 3	W	ENE, 10	NNE-W.
Pleasantville, Nor. M. S.	Hong Kong	Los Angeles	41 24 N.	154 18 W.	11	2 a, 12	12	29.14	SW	SW, 9	W	W, 9	SW-W.
Ixion, Br. S. S.	Nagoya	Vancouver, B. C.	49 26 N.	136 35 W.	13	4 p, 13	14	28.68	S	SW, 9	WSW	S, 10	S-WSW.
Texas, Am. S. S.	Cebu, P. I.	San Francisco	42 25 N.	158 40 W.	13	7 a, 14	14	28.84	S	NNW, 4	SW	SSW, 10	SSW-Var-NNW.
Djambi, Du. M. S.	Manila	Los Angeles	[3]18 00 N.	120 14 E.	13	4 p, 13	15	29.83	N	N, 7	NE	NE, 8	
Saparoea, Du. M. S.	do	Portland, Oreg.	46 06 N.	134 06 W.	15	3 p, 15	16	28.99		SE, 10	SSW	SE, 10	SE-W.
Amagisan Maru, Jap. M. S.	Yokohama	Los Angeles	39 30 N.	152 23 E.	16	4 p, 17	18	29.48	WNW	NW, 3	N	WNW, 8	WNW-N.
Texas, Am. S. S.	Cebu, P. I.	San Francisco	41 00 N.	137 10 W	18	2 p, 18	19	29.91	SW	SW, 8	WSW	W, 9	SW-W.
Mauna Ala, Am. S. S.	Seattle	Honolulu	43 48 N.	133 24 W	18	3 p, 18	19	29.50	SW	SW, 8	WNW	W, 9	S-WSW.
San Ramon Maru, Jap. M. S.	Tokuyama	Los Angeles	39 30 N.	174 00 E.	19	2 a, 19	19	29.30	NE	NE, 6	N	NE, 8	ENE-NE.

[1] December. [2] Barometer uncorrected. [3] Position approximate.

OCEAN GALES AND STORMS, JANUARY 1938—Continued

Vessel	Voyage From—	Voyage To—	Position at time of lowest barometer: Latitude	Position at time of lowest barometer: Longitude	Gale began January—	Time of lowest barometer January—	Gale ended January—	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
NORTH PACIFIC OCEAN—Continued			° ′	° ′				*Inches*					
Minnesotan, Am. S. S.	Los Angeles	Balboa	30 12 N.	116 42 W.	20	4 p, 20	20	29.93	WNW	WNW, 8	WNW	WNW, 8	None.
Pres. McKinley, Am. S. S.	Victoria, B. C.	Yokohama	51 39 N.	143 03 W.	19	6 a, 20	22	28.51	S	W, 10	W	W, 10	SW-W.
Amagisan Maru, Jap. M. S.	Yokohama	Los Angeles	43 25 N.	167 13 W.	21	Noon, 22	23	29.60	ESE	NE, 6	NNW	N, 8	N-NE.
Tatsuno Maru, Jap. S. S.	do	do	37 05 N.	160 18 E.	24	6 p, 24	25	29.63	NW	NW, 6	WNW	NW, 8	
Empress of Canada, Br. S. S.	Victoria, B. C.	Honolulu	38 58 N.	139 59 W.	24	7 a, 25	25	29.61	SE	W, 6	NNW	NNW, 9	SE-W-NW.
West Cactus, Am. S. S.	Champerico	Los Angeles	15 06 N.	93 31 W.	25	6 a, 25	26	29.89	NNE	NNE, 5	NE	N, 9	NNE-N.
Vermont, Am. S. S.	Balboa	San Diego	15 00 N.	94 00 W.	25	2 a, 25	25	29.85	NNW	NNW, 6	E	NNE, 10	N-NNW-NNE.
Minnesotan, Am. S. S.	Los Angeles	Balboa	15 00 N.	96 34 W.	25	6 p, 25	26	29.87	E	NE, 9	NNE	NNE, 11	E-NNE.
Coloradan, Am. S. S.	do	do	11 20 N.	89 00 W.	25	4 p, 26	26	29.84	ENE	NE, 6	NE	NE, 7	None.
Pres. McKinley, Am. S. S.	Victoria, B. C.	Yokohama	50 20 N.	178 05 E.	24	10 a, 26	27	28.54	SE	SW, 7	WSW	WNW, 12	SSE-W.
Golden Sun, Am. S. S.	Iloilo, P. I.	San Francisco	38 00 N.	154 35 E.	26	11 p, 26	26	29.30	SSW	SSW, 7	W	SW, 9	SSW-W.
San Pedro Maru, Jap. M. S.	Yokohama	do	38 10 N.	156 15 E.	26	2 a, 27	27	29.17	SW	SSW, 11	W	SSW, 11	S-W.
W. S. Miller, Am. S. S.	Vladivostok	do	40 48 N.	166 06 E.	26	2 p, 27	27	29.32	S	S, 10	NW	S, 10	S-NW.
Pres. McKinley, Am. S. S.	Victoria, B. C.	Yokohama	49 07 N.	171 47 E.	27	8 p, 27	28	29.16	SSE	SSE, 10	SW	SSE, 11	S-SW.
Djambi, Du. M. S.	Manila	Los Angeles	[3] 32 50 N.	162 20 W.	26	3 p, 29	30	30.14	NNE	E, 9	E	NE, 11	ENE-E.
Pres. Jackson, Am. S. S.	Yokohama	Victoria, B. C.	48 50 N.	177 00 E.	27	4 a, 28	28	29.50	S	S, 11	S	S, 11	
Missourian, Am. M. S.	Balboa	Los Angeles	10 40 N.	87 10 W.	29	4 p, 29	29	29.88	NNE	E, 5	E	NE, 7	NE-E.
Matsonia, Am. S. S.	San Francisco	Honolulu	35 30 N.	129 25 W.	30	1 p, 30	30	29.49	S	S, 8	WSW	SW, 8	S-WSW.
Pres. McKinley, Am. S. S.	Victoria, B. C.	Yokohama	40 52 N.	146 23 E.	31	2 p, 31	31	29.52	SE	ENE, 7	NE	E, 8	E-NE.
Missourian, Am. M. S.	Balboa	Los Angeles	15 48 N.	94 55 W.	31	2 p, 31	31	29.91	N	NNE, 8	NE	NNE, 9	NNW-NNE.

[3] Position approximate.

NORTH PACIFIC OCEAN, JANUARY 1938

By WILLIS E. HURD

Atmospheric pressure.—Numerous LOWS crossed the northern waters of the ocean during January. Many, as in the preceding month, were of great depth, and on more than half the days of the month the barometer read below 29 inches on some part of the North Pacific. The lowest pressure of the month, 28.02, was read at Dutch Harbor on January 14. The Aleutian cyclone, with average central pressure about 29.60 inches, lay over the region extending from the western part of the Gulf of Alaska well across the chain of the Aleutians. The average pressures there varied little from the normal, but there was a strong plus departure to the northward, as shown by St. Paul, +0.12.

In middle latitudes, the region of the usual oceanic HIGH was invaded by extensive cyclonic areas during the early half of the month. In consequence, on the average for the month, there was only a comparatively narrow anticyclonic belt extending largely between latitudes 20° and 30° N., with wider centers of higher pressure lying off the California and east China coasts, with pressure some 0.10 inch above the normal over the Nansei and Ogasawara Islands.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure at sea level, North Pacific Ocean, January 1938, at selected stations*

Stations	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Point Barrow	29.98	−0.10	30.64	11, 27	29.26	17
Dutch Harbor	29.58	.00	30.74	31	28.02	14
St. Paul	29.75	+.12	30.84	31	28.66	14
Kodiak	29.53	−.06	30.48	30	28.34	15
Juneau	29.80	−.08	30.47	28	28.69	20
Tatoosh Island	30.06	+.08	30.66	24	29.30	31
San Juan	30.12	+.01	30.54	25	29.57	31
Mazatlan	29.94	−.01	30.04	23	29.86	6, 12
Honolulu	30.00	.00	30.19	17	29.77	28
Midway Island	30.01	−.02	30.36	23, 26	29.62	31
Guam	29.86	−.04	29.92	11, 13, 18, 22, 23, 25	29.73	3
Manila	29.90	+.01	29.97	9	29.80	11
Hong Kong	30.13	+.02	30.35	8	29.88	30
Naha	30.17	+.09	30.36	9, 10	29.86	29
Titijima	30.12	+.11	30.30	10, 17, 18	29.87	2

NOTE.—Data based on 1 daily observation only, except those for Juneau, Tatoosh Island, San Francisco, and Honolulu, which are based on 2 observations. Departures are computed from best available normals related to time of observation.

Extratropical cyclones and gales.—January 1938 was a stormy month on the North Pacific, with gales of practically daily occurrence on some part of the ocean, and winds of the higher forces, 11 to 12, reported on the 3d, 5th, 9th, 10th, and 26th to 28th in middle and high latitudes, to the westward of the 165th meridian of west longitude.

During the 2d to 5th of the month widely scattered gales were encountered between about 140° W. and the coast of Japan. The principal storm area of the period, however, lay to the westward of the 180th meridian, with reported gales occurring between latitudes 30° and 45° N. On the 2d the center of a cyclone of some magnitude lay east of the island of Hokushu, whence it moved east-northeastward, and on the 6th crossed the central Aleutians. The heaviest winds reported in connection with the storm occurred far south of the center. The Japanese motorship *San Pedro Maru*, near 34° N., 145° E., on the 3d, met a west hurricane while the storm center lay near 45° N., 160° E., and the British motorship *Silverbelle* encountered a like wind near 37° N., 165 E., while the center was close to 46° N., 180°.

On the 7th another storm lay to the immediate east of Japan. It rapidly developed in depth and extent as it moved eastward, but no important gales occurred in connection with it until the 9th when the American steamer *Texas* eastbound toward San Francisco ran into heavy gales which increased to force 12 in the afternoon, near 38° N., 172° E., continuing until the morning of the 10th, lowest barometer 28.72. On the same date also the Dutch motorship *Saparoea*, far to the northeastward near 44° N., 171° W., was also involved in hurricane winds, lowest barometer 28.69. During the 9th and 10th the cyclone area extended over two-thirds or more of the width of the ocean in high latitudes, and caused scattered gales of force 9 to 10 as far to the eastward along the northern routes as about longitude 150° W. Similar conditions prevailed until the 15th, with low pressures and strong to whole gales scattered over a wide area of the upper routes in west longitudes. By the 15th and 16th the gale region had extended well toward the coast of the United States, as indicated by the report of the motorship *Saparoea* which encountered a force-10 wind from southeast on the 15th, near 46° N., 134° W., followed

by lessening gales which were still of force 8 on the 16th close to the Oregon coast. The cyclone center on these dates lay close to the Alaskan Peninsula. From the 17th to 22d it fluctuated over the Gulf of Alaska, with narrowed sphere of influence, although it continued to cause strong westerly gales a day's journey or less out from the Oregon coast on the 18th and 19th. On the 20th, also, Washington coastal winds were strong, with a velocity of 61 miles for a 5-minute period from the south reported at North Head.

On January 25 a rather deep cyclone, central in the Japan Sea, caused strong southwesterly gales in west and east coastal waters of Honshu. The storm center, with great rapidity and increasing intensity, moved northeastward across the Kuril Islands and on the 26th and 27th lay near the east coast of Kamchatka, lowest pressure 28.35, where it merged with another disturbance of the 24th–25th from the western Aleutians. The western part of the northern steamship routes was strongly affected by the major storm, the heavy weather extending as far eastward on the north as the central Aleutians, and on the south, at approximately 35° N., as far east as about 170° E. On the 26th and 27th the Japanese motorship *San Pedro Maru* met southwesterly gales of force 11 near 46° N., 156° E., and the American steamship *President McKinley* had westerly to southwesterly gales of forces 11–12 between 49° and 50° N., longitudes 178° to 172° E., lowest barometer 28.54, on the same dates. In addition, on the 28th, the western Aleutian region continued to be heavily disturbed, with the American steamship *President Jackson* encountering a force-11 gale from the south near 49° N., 177° E.

Late in the month there was some storminess to the northward of the central Hawaiian Islands along the southern border of a high pressure area. The strongest gale of the locality and period reported was of force 11, northeast, barometer 30.14, encountered by the Dutch motorship *Djambi* near 33° N., 162° W., on the 27th.

Tropical disturbances.—During the 12th (local time) a LOW passed across the central Philippines into the China Sea. No high winds appear to have been directly connected with it, although near the north end of Luzon on the 13th, the Dutch motorship *Djambi* experienced a gale of force 8. An account of this and of an earlier disturbance, by the Rev. Bernard F. Doucette, S. J., Manila Observatory, is subjoined.

On the 11th to 13th there were some evidences of the formation of a tropical LOW between the Revillagigedo Islands and Lower California. It was indicated largely by the wind circulation and slightly depressed barometer, as no winds of higher force than 6 were observed.

On the 29th a LOW of tropical origin appeared central in the vicinity of 20° N., 165° W. It moved northwestward and on the 31st was central near Midway Island where the barometer fell to 29.62. During the course of the disturbance up to the close of the month, fresh gales were reported by steamers to the northward of the center.

Tehuantepecers and Chubascos.—Near the close of the month there was pronounced "norther weather" in the Gulf of Tehuantepec. During a passage of the Gulf on the 25th–26th the American steamer *Minnesotan* encountered wind velocities of force 11 from the northeast. On the 31st, in the same locality, there was a gale of force 9. Off the Costa Rican coast northeast Chubascos of force 7 were reported on the 26th and 29th.

Fog.—There was little fog on the North Pacific this month. The only coastal fogs reported by ships were those of the 8th and 27th off southern and Lower California, and of the 31st in the Gulf of Tehuantepec. Along the strip 30° to 50° N., 130° to 140° W., scattered fog was observed on the 3d to 6th and on the 9th. It was observed on one day near 44° N., 179° E.

TYPHOONS AND DEPRESSIONS OVER THE FAR EAST

By BERNARD F. DOUCETTE, S. J.

[Weather Bureau, Manila, P. I.]

Depression, January 6–10, 1938.—During the last few days of December 1937 and the following days in January 1938, there was a persistent low pressure trough extending from southern Mindanao eastward to the Western Caroline Islands, and perhaps farther. At various times, pressure at Yap would fall and the winds would shift as though a depression, even a typhoon, were forming. For a day or so, these conditions would last and then the ordinary normal weather would be reported. Reports from Java and nearby regions indicated the presence of a rather strong, steady southwesterly current of air during these days. It is the opinion of the writer that all the conditions for the formation of a disturbance were present but the region of action was so close to the equator that no sustained development took place.

On January 6 a definite center appeared about 150 miles west of Yap. It moved northwest, then west, and after being stationary 1 day (January 8), it recurved to the northeast and disappeared on the afternoon of January 10.

Typhoon, January 11–13, 1938.—The morning of January 11, there seemed to be another depression center about 300 miles east of Surigao, which moved in a northwesterly direction, intensifying the same afternoon when about 150 miles east of Samar. That evening, the center had moved to a position close to and east of Virac, where it weakened rapidly as its course changed to the west-by-south. It crossed southern Luzon as a depression during the night and was located the next morning (January 12) over Ragay Gulf. From this position, it moved north-northwest and northwest to northern Luzon, now only a weak low pressure area. It had entirely disappeared by the afternoon of January 13. On January 11, at 4 p. m., Virac, Catanduanes Island, reported a pressure of 749.6 mm. (29.512 in.) with west-northwest winds force 6. This was just before the typhoon changed its course to the west-by-south and weakened.

It should be noted that this analysis of the situation is based almost entirely upon synoptic observations made at Guam, Yap, and Palau, combined with observations made over the Philippines. No ships' observations north of the region under consideration have been available. It is possible, but no observations are available for confirmation, that an active typhoon center existed part of the time, without rapid movement in any particular direction, and that the disturbance approaching the Philippines January 11 could be this typhoon in its final stages.

CLIMATOLOGICAL TABLES

[Climate and Crop Weather Division, J. B. KINCER in charge]

DESCRIPTION OF TABLES AND CHARTS

By J. P. KOHLER

Table 1 presents average and extreme values for 45 climatic districts, based on all available data ascertained by regular and cooperative Weather Bureau stations.

Table 2 gives the data ordinarily needed for climatological studies for about 180 Weather Bureau stations making simultaneous observations at 7:30 a. m. and 7:30 p. m. daily, seventy-fifth meridian time, and for about 20 others making only one observation. The altitudes of the instruments above ground are also given.

Beginning with January 1, 1932, all wind movements and velocities published herein are corrected to true values by applying to the anemometer readings, corrections determined by actual tests in wind tunnels and elsewhere.

Table 3 gives, for about 37 stations of the Canadian Meteorological Service, the means of pressure and temperature, total precipitation, depth of snowfall, and the respective departures from normal values, except in the case of snowfall. The sea-level pressures have been computed according to the method described by Prof. F. H. Bigelow in the REVIEW of January 1902, **30**: 13–16.

Table 4 lists the severe local storms reported in the United States during the month. It is compiled from reports furnished mostly by officials of the Weather Bureau.

In regard to discussion of charts that follow: Charts I, IV, V, and VI are based on observational data from stations listed in table 2.

CHART I.—*Temperature departures.*—This chart presents the departures of the monthly mean surface temperatures from the monthly normals. The shaded portions of the chart indicate areas of positive departures and unshaded portions indicate areas of negative departures. Generalized lines connect places having approximately equal departures of like sign. This chart of monthly surface temperature departures in the United States was first published in the MONTHLY WEATHER REVIEW for July 1909, but smaller charts appear in W. B. Bulletin U for 1873 to June 1909, inclusive.

CHART II.—*Tracks of centers of* ANTICYCLONES; and

CHART III.—*Tracks of centers of* CYCLONES. The roman numerals show the chronological order of the centers. The figures within the circles show the days of the month, the location indicated being that at 7:30 a. m., seventy-fifth meridian time. Within each circle is also an entry of the last three figures of the highest barometric reading (chart II) or (chart III) the lowest reading reported at or near the center at that time, in both cases as reduced to sea level and standard gravity. The intermediate 7:30 p. m. locations are indicated by dots. The inset map on chart II shows the departure of monthly mean pressure from normal and the inset on chart III shows the change in mean pressure from the preceding month.

The use of a new base map for charts II and III began with the January 1930 issue.

CHART IV.—*Percentage of clear sky between sunrise and sunset.*—The average cloudiness at each regular Weather Bureau station is determined by numerous personal observations between sunrise and sunset. The difference between the observed cloudiness and 100 is assumed to represent the percentage of clear sky, and the values thus obtained are the basis of this chart. The chart does not relate to the night hours.

CHART V.—*Total precipitation.*—The scales of shading with appropriate lines show the distribution of the monthly precipitation according to reports from both regular and cooperative observers. The inset on this chart shows the departure of the monthly totals from the corresponding normals, as indicated by the reports from the regular stations.

CHART VI.—*Isobars at sea level and isotherms at surface, prevailing winds.*—The pressures have been reduced to sea level and standard gravity by the method described by Prof. Frank H. Bigelow in the REVIEW for January 1902, **30**: 13–16. The pressures have also been reduced to the mean of the 24 hours by the application of a suitable correction to the mean of 7:30 a. m. and 7:30 p. m. readings at stations taking two observations daily, and to the 7:30 a. m. or the 7:30 p. m. observation at stations taking but a single observation.

The diurnal corrections so applied, except for stations established since 1901, will be found in the Annual Report of the Chief of the Weather Bureau, 1900–1901, volume 2, table 27, pages 140–164.

The sea-level temperatures are now omitted and average surface temperatures substituted. The isotherms cannot be drawn in such detail as might be desired, for data from only the regular Weather Bureau stations are used.

The prevailing wind directions are determined from hourly observations at almost all the stations. A few stations determine their prevailing directions from the daily or twice-daily observations only.

CHART VII.—*Wind roses for selected stations.*—The publication of this chart began in the REVIEW for January 1935 and gives wind roses for 28 selected stations. The roses are based on hourly percentages for the month.

CHART VIII.—*Total snowfall.*—This is based on the reports from regular and cooperative observers and shows the depth in inches of the snowfall during the month. In general, the depth is shown by lines connecting places of equal snowfall, but in special cases figures also are given. This chart is published only when the snowfall is sufficiently extensive to justify its preparation. The inset on this chart, when included, shows the depth of snow on the ground at 7:30 p. m. of the Monday nearest the end of the month and is a copy of the snow chart appearing in the Snow and Ice Bulletin for that week. Generally, the publication of the Weekly Snow and Ice Bulletin commences about the middle of December and continues to near the close of March.

CHARTS IX, X, ETC.—*North Atlantic weather maps for particular days.*

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

TABLE 1.—*Condensed climatological summary of temperature and precipitation by sections, January 1938*

Section	Temperature								Precipitation					
	Section average	Departure from the normal	Monthly extremes						Section average	Departure from the normal	Greatest monthly		Least monthly	
			Station	Highest	Date	Station	Lowest	Date			Station	Amount	Station	Amount
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Alabama	48.1	+1.7	2 stations	81	[1] 23	Tuscumbia	11	28	3.39	−1.45	Bishop	7.14	Maxwell Field	1.75
Arizona	44.5	+2.7	do	83	[1] 3	Springerville	−4	26	.66	−.67	Bright Angel	3.40	Yuma Citrus	.00
Arkansas	42.5	+1.1	El Dorado	81	21	Devil Knob	4	[1] 16	6.48	+2.04	Grannis	11.58	Calico Rock	2.87
California	46.2	+1.6	Yorba Linda	90	9	Twin Lakes	−10	20	3.72	−1.06	Scales	13.64	Brawley	.00
Colorado	26.9	+3.0	Holly	73	18	Fraser	−30	7	.82	+.06	Pagosa Springs (near).	6.77	2 stations	T
Florida	58.6	−.6	Lake Placid	88	7	Garniers (near)	15	27	2.04	−.73	Jacksonville	5.21	Lake Placid	.10
Georgia	47.4	+.3	Stillmore	82	23	2 stations	8	28	2.01	−2.26	Lafayette	4.03	Glenville	.61
Idaho	27.7	+3.8	2 stations	62	[1] 12	Obsidian	−19	25	1.80	−.39	Roland	7.47	Arco	.10
Illinois	28.5	+.8	Harrisburg	62	24	Freeport	−7	31	2.57	+.18	Fairview	5.02	Hillsboro	1.05
Indiana	29.6	+.5	Shoals	66	24	Goshen	−11	28	1.72	−1.42	Laporte	5.17	Shelbyville	.43
Iowa	21.0	+2.5	Thurman	59	22	Marshalltown	−25	10	1.14	+.04	Burlington	3.79	2 stations	.15
Kansas	34.6	+4.9	Liberal	75	15	Burr Oak	−12	31	.45	−.22	Oswego	2.73	11 stations	.00
Kentucky	35.9	−.1	Pikeville	72	24	Greenville	−4	27	3.56	−.99	Cumberland	6.25	Grant	1.57
Louisiana	52.7	+.9	Donaldsonville	84	22	4 stations	20	[1] 11	4.98	+.05	Jonesville	7.58	Shreveport	2.25
Maryland-Delaware	33.6	−.1	Cumberland, Md	67	30	Oakland, Md	−2	29	2.32	−.98	Snow Hill, Md	3.90	Keedysville, Md	.91
Michigan	19.5	−1.5	Monroe	55	24	Iron Mountain	−32	28	2.54	+.67	Munising	6.73	Port Huron	.43
Minnesota	8.7	−.5	2 stations	47	23	Warroad	−41	31	.60	−.16	Duluth	1.55	Alexandria	.07
Mississippi	48.2	+.7	Port Gibson	85	22	Forest	15	27	4.85	−.31	Holly Springs	10.97	Forest	2.39
Missouri	33.1	+2.3	Garber	75	16	Tarkio	−9	31	2.93	+.53	Mountain Grove	5.55	Tarkio	.39
Montana	24.6	+5.2	2 stations	61	27	Summit	−47	30	.60	−.27	Haugan	3.87	Bridger	T
Nebraska	28.1	+5.1	Broken Bow	72	15	Nenzel (near)	−22	31	.35	−.17	Hartington	1.10	4 stations	T
Nevada	35.2	+5.8	Las Vegas	80	22	Elko	−5	24	.74	−.44	Marlette Lake	3.30	Mina	00
New England	21.4	−1.3	4 stations	59	[1] 7	First Conn. Lake, N. H.	−34	[1] 18	4.16	+.63	Danbury, Conn	7.68	Presque Isle, Maine	1.38
New Jersey	31.0	+.1	Canoe Brook	68	25	Layton	−19	19	3.64	+.07	Paterson	5.73	Camden	2.58
New Mexico	34.1	+.5	Tularosa	89	6	Eagle Nest	−28	7	.57	+.01	Chama	2.90	4 stations	.00
New York	22.4	−.9	Albany	61	25	Indian Lake	−31	19	2.91	−.06	Bedford Hills	5.57	Avon	.96
North Carolina	41.1	−.6	2 stations	76	[1] 23	Mount Mitchell	−10	[1] 28	2.89	−.90	Siler City	5.15	Red Springs	1.46
North Dakota	9.5	+3.4	Carrington	50	15	Hannah	−40	31	.48	−.01	Carson	1.47	Mayville	.01
Ohio	30.0	+1.5	3 stations	72	24	Xenia	−5	28	1.62	−1.50	Chilo	2.99	Put-in-Bay	.48
Oklahoma	42.2	+3.9	Seminole	82	17	2 stations	0	31	1.44	+.01	Idabel	11.49	2 stations	.00
Oregon	34.7	+3.0	Brookings	71	9	2 stations	−8	[1] 7	3.39	−.47	Valsetz	16.96	Mitchell	.41
Pennsylvania	28.9	+.4	Claysville	66	[1] 24	Gouldsboro	−20	19	2.51	−.75	Mt. Pocono	5.95	Vandergrift	.87
South Carolina	45.5	−.4	3 stations	79	22	2 stations	5	28	1.50	−2.08	Landrum	3.53	Wedgefield	.55
South Dakota	19.5	+2.9	Ardmore	65	4	Pollock	−30	31	.52	−.03	Dummont	3.12	Orman	.06
Tennessee	39.6	+.4	Newport	74	24	Rugby	−4	28	5.38	+.46	Ashwood	8.73	Dresden	2.74
Texas	50.2	+2.0	Laredo	92	18	Spearman	4	31	2.81	+1.12	Naples	10.98	3 stations	.00
Utah	30.8	+5.7	St. George	66	28	Loa	−11	21	.91	−.29	Silver Lake	4.05	Myton	.00
Virginia	36.3	−.3	2 stations	69	[1] 1	Mountain Lake	−3	27	2.73	−.60	Pennington Gap	4.65	Riverton	.87
Washington	34.0	+3.4	Signal Peak	63	10	Stockdill Ranch	−6	29	3.53	−1.62	Wynoochee Oxbow	14.64	Rock Island (near)	.29
West Virginia	33.5	+.7	London	77	24	Flat Top	−2	27	2.22	−1.48	Pickens	4.41	Wardensville	.66
Wisconsin	15.0	.0	3 stations	48	23	Solon Springs	−40	31	2.03	+.79	Milwaukee	4.60	Holcombe	.70
Wyoming	22.2	+2.3	Fort Laramie	63	15	Buffalo Ranch	−37	30	.79	.00	Bechler River	5.29	Evanston	.04
Alaska (December)	6.5	+1.9	Wrangell	56	[1] 5	2 stations	−54	[1] 29	2.11	−.34	Little Port Walter	21.02	Anchorage	T
Hawaii	70.3	+1.5	Kohala	89	13	Kula Sanitarium	45	9	10.09	+1.59	Piihonua	40.01	Napoopoo	.72
Puerto Rico	72.8	−.1	Juncos	92	13	Lares	51	26	2.00	−1.68	La Mina (El Yunque)	12.39	5 stations	.00

[1] Other dates also.

TABLE 2.—*Climatological data for Weather Bureau stations, January 1938*

[Compiled by Annie E. Small, by official authority U. S. Weather Bureau]

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature: Departure from normal	Temperature: Maximum	Temperature: Date	Temperature: Mean maximum	Temperature: Minimum	Temperature: Date	Temperature: Mean minimum	Temperature: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 inch or more	Wind: Average hourly velocity	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F		°F	°F.		°F	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
New England							25.2	+0.7										76	3.74	+0.3										5.8		
Eastport	76	67	85	29.96	30.04	+0.04	22.8	+2.4	50	25	30	−6	18	16	31	21	16	73	2.07	−1.8	8	12.6	nw.	45	s.	25	11	6	14	5.7	6.4	2.5
Greenville, Maine	1,070	6	40																													
Portland, Maine	103	82	117	29.92	30.05	.00	23.8	+1.4	49	25	32	−1	19	16	26	22	17	75	4.13	+.2	9	8.8	n.	41	s.	25	14	7	10	4.8	16.2	.4
Concord	289	54	72	29.71	30.05	.00	21.0	−.6	55	25	32	−18	19	10	44				3.94	+.9	11	4.6	n.	19	s.	25	11	10	10	5.2	20.4	.8
Burlington	403	11	48	29.57	30.04	.01	17.2	−1.6	55	25	26	−16	19	9	31	15	11	81	1.99	+.2	14	9.0	s.	36	s.	30	7	4	20	7.0	8.5	.8
Northfield	876	12	60	29.05	30.05	.00	14.8	−.4	55	25	26	−25	18	3	42	12	10	87	2.73	+.4	12	6.3	s.	32	sw.	25	7	10	14	6.4	17.4	3.0
Boston [1]	29	33	62	30.01	30.04	−.01	28.0	+.1	57	7	35	3	19	21	29	25	21	76	4.91	+1.3	11	10.7	w.	48	s.	25	8	12	11	6.0	20.6	.2
Nantucket	12	14	90	30.02	30.03	−.01	33.0	+1.7	54	7	38	19	29	28	20	30	27	82	4.39	+.6	12	13.2	nw.	41	se.	25	11	4	16	6.3	11.3	T
Block Island	26	11	46	30.02	30.04	−.03	32.2	+1.2	56	7	38	14	19	27	22	30	25	74	2.73	−1.0	12	16.2	nw.	40	ne.	1	11	9	11	5.3	5.3	.0
Providence	159	215	251	29.87	30.05	−.01	28.4	+1.2	57	7	36	2	19	21	26	25	20	73	4.37	+.7	12	10.8	nw.	46	s.	25	15	4	12	5.1	19.7	T
Hartford	159	66	100	29.88	30.06	−.01	26.6	+1.1	58	25	34	−5	19	19	29				5.62	+1.7	11	7.7	n.	34	s.	25	11	9	11	5.7	23.6	.7
New Haven	106	74	153	29.94	30.06	−.02	29.0	+.8	55	25	36	−1	19	22	24	26	19	66	4.23	+.2	13	9.1	n.	35	se.	25	10	6	15	6.1	15.3	.3
Middle Atlantic States							33.5	+1.4										72	2.68	−0.6										6.9		
Albany	97	97	112	29.96	30.07	.00	22.6	−.5	61	25	31	−16	19	14	27	20	15	72	3.49	+1.1	15	6.8	n.	31	s.	25	6	6	19	7.2	17.2	T
Binghamton	871	57	79	29.07	30.03	−.05	25.5	+1.4	58	25	33	−14	19	18	37	24	21	86	2.13	−.3	16	6.7	ne.	22	sw.	25	0	5	26	8.9	4.6	.8
New York	314	415	454	29.71	30.06	−.04	32.0	+1.1	56	30	39	5	18	25	25	29	23	70	3.37	−.3	15	14.3	nw.	59	s.	25	7	10	14	6.6	6.1	.0
Harrisburg	374	94	104	29.64	30.06	−.04	31.0	+2.0	58	25	38	7	19	24	31	28	21	67	2.07	−1.0	11	7.9	w.	32	sw.	26	4	8	19	7.2	2.5	.0
Philadelphia	114	174	367	29.95	30.08	−.03	33.6	+1.0	58	25	40	11	19	27	26	31	25	71	2.32	−1.0	11	12.3	nw.	49	s.	25	7	8	16	6.7	2.8	.0
Reading	323	283	306	29.70	30.07		32.2	+2.8	63	25	39	5	19	25	32	29	23	69	2.19	−1.4	13	10.6	nw	45	sw.	25	3	12	16	7.1	5.3	T
Scranton	805	72	104	29.14	30.04	−.05	27.9	+1.3	60	25	35	−2	19	21	34	25	19	69	2.41	−.6	13	6.5	sw.	34	se.	24	1	11	19	7.5	8.4	1.5
Atlantic City	52	37	172	30.01	30.07	−.04	35.8	+3.3	53	25	42	17	19	30	21	32	27	74	3.26	−.2	14	14.6	w.	51	se.	25	4	12	15	7.0	T	.0
Sandy Hook	22	10	57	30.03	30.05		32.6	+1.3	55	30	38	12	19	27	24	30	26	77	3.32	−.6	15	14.3	nw.	55	s.	25	7	7	17	6.7	2.9	.0
Trenton	190	88	106	29.85	30.06		32.2	+1.7	60	25	39	7	19	25	26	29	23	70	2.83	−.5	15	8.9	nw.	34	se.	25	2	15	14	7.2	2.5	.0
Baltimore	123	100	215	29.94	30.07	−.05	36.2	+2.4	61	30	43	17	19	30	28	31	25	66	2.23	−1.3	10	10.0	sw.	41	s.	24	6	11	14	6.5	1.4	.0
Washington	112	62	85	29.94	30.07	−.06	35.7	+2.3	63	25	43	18	28	29	29	31	25	67	2.64	−.9	11	6.9	nw.	26	sw.	30	5	12	14	6.7	1.5	.0
Cape Henry	18	8	54	30.06	30.08		40.0	−.2	68	1	47	20	29	34	29	36	32	74	2.50	−.6	12	11.6	n.	40	n.	31	7	8	16	6.7	T	.0
Lynchburg	686	144	184	29.32	30.09	−.04	38.1	+.6	67	17	47	13	28	29	37	33	27	69	2.99	−.4	12	7.2	nw.	40	nw.	13	9	7	15	6.1	1.2	.0
Norfolk	91	80	125	30.00	30.10	−.03	41.2	+.6	69	1	48	20	27	34	32	36	32	74	2.80	−.3	14	9.5	n.	44	s.	25	8	5	18	6.8	.7	.0
Richmond	144	11	52	29.93	30.10	−.04	38.2	+.3	65	17	47	17	27	30	33	34	29	76	2.96	−.2	14	8.1	sw.	32	sw.	25	8	10	13	6.4	.5	.0
Wytheville	2,304	49	55	27.60	30.06	−.08	34.8	+1.8	50	24	43	8	27	26	40	31	27	78	2.07	−1.0	15	8.4	w.	34	w.	25	10	7	14	6.2	4.1	.0
South Atlantic States							46.7	+0.6										75	2.16	−1.3										6.1		
Asheville	2,253	89	104	27.68	30.11	−.04	38.2	+2.8	64	24	48	10	27	29	44	33	29	76	2.59	−.5	12	9.1	nw.	27	nw.	13	8	9	14	6.1	1.5	.0
Charlotte	779	63	86	29.23	30.09	−.06	42.4	+1.2	70	22	50	15	28	34	30	38	32	70	1.94	−2.1	11	7.7	sw.	33	sw.	25	10	4	17	6.5	T	.0
Greensboro [1]	886	6	56	29.12	30.10		38.3		64	17	47	11	28	29	35	34	29	80	2.82		12	7.9	sw.	34	sw.	25	9	5	17	6.3	1.8	.0
Hatteras	11	5	50	30.07	30.08	−.06	45.6	−1.5	66	1	52	27	29	40	26	43	40	85	3.00	−1.4	11	14.1	n.	41	w.	26	9	9	13	5.9	.0	.0
Raleigh	376	103	140	29.67	30.08	−.05	42.0	+.9	70	1	50	16	28	34	30	37	32	74	2.46	−1.2	11	8.4	sw.	27	sw.	25	7	10	14	6.3	1.1	.0
Wilmington	72	73	107	30.03	30.11	−.03	46.9	+.4	71	22	56	21	28	38	28	42	38	76	2.26	−1.0	7	9.2	n.	35	sw.	24	10	8	13	5.9	.0	.0
Charleston	48	11	92	30.06	30.11	−.04	50.3	+.4	75	22	57	23	28	43	22	45	40	75	1.12	−1.9	8	9.3	n.	28	w.	25	7	8	16	6.7	.0	.0
Columbia, S. C.	347	70	91	29.72	30.11	−.04	46.6	+.6	75	22	55	20	28	38	32	41	34	68	1.17	−2.2	7	8.7	sw.	35	sw.	25	10	6	15	5.9	T	.0
Greenville, S. C.	1,039	139																														
Augusta	182	62	77	29.90	30.09	−.07	47.6	+.6	76	22	57	21	28	39	33	42	36	70	1.20	−2.7	10	6.4	nw.	30	sw.	25	9	7	15	6.1	T	.0
Savannah	65	73	152	30.04	30.11	−.04	52.2	+.8	77	22	61	24	28	44	25	46	41	74	.68	−2.1	11	10.6	nw.	35	nw.	25	11	5	15	5.9	.0	.0
Jacksonville	43	86	110	30.08	30.13	−.02	55.6	+.2	78	1	64	27	28	47	28	49	45	76	5.21	+2.4	10	7.8	w.	30	sw.	25	11	6	14	5.3	.0	.0
Florida Peninsula							64.2	−0.1										78	1.28	−1.2										4.5		
Key West	21	10	64	30.07	30.09	−.01	69.4	−.1	82	24	75	51	28	64	23	63	61	81	.30	−1.7	3	9.6	n.	33	nw.	25	12	15	4	4.4	.0	.0
Miami	25	124	168	30.08	30.11	−.02	67.3	+.8	80	11	74	44	28	61	25	61	57	75	2.42	−.1	5	9.4	se.	24	n.	28	12	13	6	4.5	.0	.0
Tampa	35	8	197	30.08	30.12	.00	61.0	+.6	80	24	70	36	27	52	28	54	51	77	1.20	−1.5	10	10.5	n.	32	nw.	25	13	11	7	4.5	.0	.0
Titusville	43	5	36	30.06	30.10		59.0	−1.8	82	23	70	27	28	48	33	53	51		1.19	−1.3	5		nw.				9	9	13		.0	.0
East Gulf States							49.5	+0.9										74	3.05	−1.7										6.9		
Atlanta [1]	976	5	53	29.05	30.10	−.05	43.0	+.4	72	22	52	16	28	35	33	38	34	75	1.86	−3.1	11	9.6	nw.	32	sw.	25	7	8	16	6.3	.3	.0
Macon	370	79	87	29.71	30.11	−.05	47.7	+.9	75	22	57	21	28	39	31	44	40	80	1.68	−2.5	9	7.3	nw.	24	sw.	24	8	8	15	6.1	.0	.0
Thomasville	273	49	58	29.83	30.13	−.03	53.2	+2.2	78	22	62	24	27	44	31	47	44		2.24	−1.9	11		sw.								.0	.0
Apalachicola	35	11		30.08	30.12		54.3	+.6	73	24	61	30	27	48	20	50	47	80	3.37	−.3	11	8.3	nw.	26	nw.	25	10	9	12	5.8	T	.0
Pensacola	56	149	185	30.06	30.13	−.01	52.2	−.3	70	18	59	28	27	46	22	48	44	76	2.10	−1.9	11	12.3	n.	43	nw.	24	9	9	13	5.6	.0	.0
Anniston	741	9					44.5	+2.3	71	28	53	16	28	36	32				3.26	−1.9	12		nw.				12	8	11		T	.0
Birmingham	700	11	48	29.35	30.13	−.03	46.0	+.9	77	22	55	19	27	37	32	40	35	72	3.69	−1.8	10	8.2	nw.	36	se.	24	10	10	11	5.6	T	.0
Mobile	57	86	161	30.07	30.13	−.02	51.8	+.3	74	22	60	28	27	44	29	47	42	75	2.87	−2.0	10	10.1	nw.	31	w.	24	7	8	16	6.4	.0	.0
Montgomery	218	92	105	29.87	30.13	−.03	48.6	+.4	76	24	57	24	27	40	32	45	37	70	2.39	−2.8	10	7.9	n.	27	w.	25	9	7	15	6.2	.0	.0
Meridian	375	67	92	29.71	30.12	−.04	48.2	+1.2	77	22	58	21	27	39	33	43	38	74	4.42	−.9	12	7.2	sw.	29	sw.	23	11	8	12	5.5	.0	.0
Vicksburg	247	82	102	29.85	30.12	−.03	49.4	+1.2	79	21	58	26	27	41	33	43	38	68	3.47	−1.9	9	9.5	n.	32	w.	24	5	12	14	6.4	.0	.0
New Orleans	53	76	84	30.07	30.13	.00	55.0	+.8	80	21	63	32	26	47	26	49	45	75	5.27	+.9	11	7.7	se.	27	sw.	24	8	10	13	5.8	.0	.0
West Gulf States							51.0	+2.7										70	3.86	+1.1										5.6		
Shreveport	249	92	227	29.84	30.12	−.02	50.8	+3.8	79	21	59	25	31	42	35	45	40	69	2.25	−1.7	9	12.2	ne.	47	nw.	24	11	8	12	5.6	T	.0
Bentonville	1,303	12	38	28.74	30.14	.00	38.2	+4.1	70	16	48	7	31	28	46				3.11	+.4	8	8.0	sw.	24	sw.	29	11	11	9		.5	.0
Fort Smith	463	57	82	29.63	30.13	−.01	42.5	+3.0	74	16	52	14	31	33	43	37	29	63	3.51	+1.0	6	8.6	e.	30	nw.	24	14	8	9	4.7	T	.0
Little Rock	357	94	102	29.73	30.12	−.03	43.0	+1.6	69	16	52	18	31	35	37	38	32	67	9.80	+5.1	8	9.1	nw.	30	sw.	16	11	5	15	5.8	T	.0
Austin	605	68	90	29.46	30.10		52.2	+2.7	82	18	61	24	31	43	38	47	42	72	3.93	+1.9	7	8.2	n.	30	n.	25	13	6	12	5.2	.0	.0
Brownsville	57	88	96	30.00	30.06		61.6	+1.8	82	17	68	34	26	55	30	57	53	79	.92	−.6	8	11.5	s.	32	s.	30	12	5	14	5.7	.0	.0
Corpus Christi	20	11	78	30.07	30.09	−.01	59.2	+3.2	77	18	65	33	31	53	32	55	51	79	1.39	−.2	6	11.4	n.	38	n.	30	12	4	15	5.9	.0	.0
Dallas	512	220	227	29.55	30.11		48.8		75	16	56	19	31	41	38	43	36	65	6.34	+4.0	8	12.3	n.	42	w.	24	15	9	11	5.4	T	.0
Fort Worth	679	92	110	29.39	30.11	−.01	49.2	+3.8	78	16	58	18	31	41	42				2.74	+.7	9	9.7	n.	39	n.	24	15	6	10	4.6	.0	.0
Galveston	54	106	114	30.05	30.11	−.02	55.4	+1.6	68	17	60	35	31	50	28	52	48	79	3.63	+.2	12	11.7	n.	38	nw.	25	11	5	15	5.7	.0	.0
Houston	138	292	314	29.97	30.12		55.0	+2.3	78	18	62	28	31	48	33				3.34	−.4	11	12.8	se.	35	nw.	25	9	7	15	6.0	.0	.0
Palestine	510	64	72	29.58	30.12	.00	50.6	+2.4	78	18	58	22	31	43	36	44	37	65	4.26	+1.8	9	8.2	n.	27	nw.	25	8	9	14	6.3	T	.0
Port Arthur	34	98	106	30.08	30.12		54.2		73	20	61	33	31	47	29				5.50	+1.8	10	14.1	n.	41	s.	22	9	7	15	6.1	.0	.0
San Antonio	693	242	301	29.37	30.10	.00	54.5	+2.2	85	18	63	27	31	46	34	48	42	66	3.35	+1.9	7	12.0	n.	34	nw.	24	11	10	10	5.6	.0	.0

[1] Observations taken at airport.

TABLE 2.—*Climatological data for Weather Bureau Stations, January 1938*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 inch or more	Wind: Average hourly velocity	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
Ohio Valley and Tennessee							**34.7**	**+1.1**										**74**	**2.73**	**−1.1**										**6.7**		
Chattanooga	762	71	214	29.27	30.10	−0.06	42.8	+1.6	69	24	51	17	28	35	29	38	32	70	4.11	−1.2	12	8.4	w.	35	se.	24	8	8	15	6.4	0.1	0.0
Knoxville	995	66	84	29.01	30.09	−.06	40.3	+1.5	70	24	49	14	27	32	33	36	31	74	4.30	−.4	14	6.0	w.	27	w.	24	9	10	12	6.1	2.8	.0
Memphis	399	78	86	29.67	30.11	−.05	41.8	+.9	69	23	49	19	26	34	37	37	30	65	5.61	+.8	7	9.0	nw.	27	w.	25	12	8	11	5.3	.0	.0
Nashville	546	168	188	29.52	30.12	−.04	38.9	+.3	65	16	47	15	27	30	34	35	30	73	5.81	+1.0	10	9.5	w.	33	s.	24	9	5	17	6.6	.1	.0
Lexington	989	6					33.6	+.7	60	24	42	3	28	25	29				3.77	−.4	12		w.				11	3	17		2.8	.0
Louisville	525	188	234	29.50	30.10	−.04	34.3	−.1	60	24	42	7	25	27	29	31	26	72	2.47	−1.5	10	11.3	s.	37	se.	24	10	8	13	6.1	.6	.0
Evansville	431	76	116	29.60	30.09	−.05	34.8	+1.3	59	24	42	9	27	27	30	31	26	73	3.54	−.2	11	10.1	nw.	43	sw.	24	11	4	16	6.2	6.7	.0
Indianapolis	822	194	230	29.14	30.05	−.07	29.4	+1.0	54	24	36	5	28	22	32	27	21	72	1.00	−2.0	11	11.3	w.	43	sw.	24	6	6	19	7.4	2.2	.0
Terre Haute	575	63	149	29.40	30.04		30.6		56	24	38	5	28	23	34	28	24	78	1.42	−1.3	12	10.2	nw.	40	sw.	24	7	6	18	6.8	4.1	.0
Cincinnati	627	11	51	29.36	30.06	−.06	32.4	+2.1	60	24	40	5	28	25	29	29	24	75	1.68	−1.8	8	9.0	sw.	30	s.	24	7	5	19	6.7	3.6	.1
Columbus	822	90	210	29.14	30.05	−.06	31.2	+2.6	63	24	38	7	28	24	31	28	23	74	1.11	−2.0	9	11.2	s.	50	s.	24	4	14	13	6.6	2.9	T
Dayton	899	60	163	29.04	30.03		31.2	+1.7	60	24	38	5	28	24	29				1.18	−2.0	9	10.2	sw.	36	sw.	24	4	10	17	6.9	3.2	T
Elkins	1,947	65	83	27.95	30.09	−.03	31.2	+.8	61	30	40	5	29	22	46	28	24	78	2.25	−1.5	17	7.0	w.	30	se.	24	4	9	18	7.4	10.1	.3
Parkersburg	637	77	84	29.35	30.06	−.06	33.8	+1.3	69	24	42	8	26	26	35	30	26	77	1.77	−1.8	13	7.0	sw.	29	sw.	24	5	10	16	7.0	2.7	.1
Pittsburgh [1]	1,273	39	54	28.63	30.03	−.08	29.6	−1.1	60	24	37	5	26	23	34	26	23	78	1.98	−1.1	18	11.1	sw.	36	se.	24	2	7	22	7.8	6.7	.7
Lower Lake Region							**24.9**	**+0.4**										**79**	**1.44**	**−1.1**										**8.3**		
Buffalo	768	243	280	29.14	30.00	−.07	24.4	−.2	51	24	31	0	19	18	31	22	19	81	1.99	−1.3	20	16.8	w.	50	sw.	25	2	6	23	8.4	18.5	2.0
Canton	448	10	61	29.52	30.02		14.8	−1.5	52	25	24	−23	18	5	37	14	13	92	1.73	−.8	15	9.3	s.	29	s.	24	5	11	15	7.0	12.5	2.0
Ithaca	836	77	100	29.08	30.01		25.2	+.9	54	30	33	−9	18	17	33	23	19	76	1.72	−.5	16	9.5	se.	47	se.	24	1	4	26	8.8	9.3	1.0
Oswego	335	71	85	29.63	30.02	−.05	23.5	−.4	52	30	30	−8	19	16	26	21	16	73	2.67	−.2	21	10.8	se.	34	se.	24	2	2	27	9.1	25.9	1.0
Rochester	523	86	102	29.43	30.02	−.05	24.8	+.2	53	30	32	−5	19	18	29	22	17	70	1.37	−1.5	16	9.3	sw.	28	sw.	25	2	7	22	8.5	12.7	1.0
Syracuse	596	65	79	29.35	30.02	−.05	25.0	+.9	54	25	32	−10	19	18	33				2.01	−1.0	18	6.9	e.	25	s.	30	2	7	22	8.4	15.0	1.4
Erie	714	130	166	29.21	30.01	−.07	26.8	.0	50	24	33	5	18	20	28	25	21	77	1.46	−1.3	17	14.1	sw.	52	se.	24	3	4	24	8.4	10.2	.3
Cleveland	762	267	318	29.16	30.00	−.09	29.0	+2.5	60	24	36	6	28	22	28	26	22	78	1.07	−1.4	17	15.9	s.	47	s.	30	2	7	22	8.1	8.9	.2
Sandusky	629	5	67	29.30	30.01	−.08	28.2	+1.9	60	24	35	6	9	22	26				.91	−1.4	12	10.3	sw.	32	sw.	30	2	9	20	8.1	5.9	.1
Toledo	628	79	87	29.31	30.02	−.07	26.8	+1.0	58	24	33	5	28	20	25	24	20	77	.55	−1.6	12	10.7	w.	31	w.	25	0	11	20	8.2	4.3	T
Fort Wayne	857	69	84	29.07	30.02		26.4	+.2	56	24	33	5	28	20	29	24	22	84	.88	−1.4	13	10.6	w.	44	sw.	24	2	11	18	7.5	5.3	.0
Detroit [1]	626	5	78	29.29	30.00	−.08	24.3	−.1	52	24	30	0	28	18	22	22	18	78	.87	−1.2	12	11.1	sw.	34	sw.	25	0	6	25	8.6	4.4	T
Upper Lake Region							**18.3**	**0.0**										**83**	**2.75**	**+0.9**										**7.9**		
Alpena	609	13	89	29.27	29.97	−.07	18.4	−.7	41	30	26	−8	28	11	27	17	14	83	2.42	+.5	17	11.5	nw.	32	s.	24	5	4	22	7.9	19.5	8.8
Escanaba	612	41	49	29.30	30.00	−.05	15.0	−.4	37	22	22	−14	31	8	29	14	9	77	1.80	+.3	13	9.0	nw.	34	nw.	30	5	5	21	7.6	24.5	17.5
Grand Rapids	707	70	244	29.19	29.99	−.07	23.8	−.7	49	24	29	−9	31	18	29	22	19	81	2.39	.0	19	11.8	nw.	49	sw.	24	1	4	26	8.8	10.2	.7
Lansing	878	5	90	29.01	29.98		22.4	.0	48	24	29	−10	28	16	29	21	19	89	1.31	−.5	15	9.5	sw.	37	s.	24	1	8	22	8.4	9.9	.1
Ludington	637	5	54	29.25	29.97		22.9	−.2	42	24	28	−1	10	18	23	21	18		5.42	+3.3	16		nw.				1	2	28		30.9	13.2
Marquette	734	49	64	29.15	29.97	−.05	16.1	−.2	43	23	22	−12	31	10	28	15	13	86	3.93	+1.6	17	8.5	nw.	37	nw.	25	2	4	25	8.5	40.5	31.0
Sault Sainte Marie	614	11	52	29.27	30.00	−.06	12.0	−1.3	37	23	19	−14	27	5	29	12	10	90	2.71	+.8	20	7.8	e.	30	ne.	25	4	8	19	7.7	29.7	24.9
Chicago	673	7	131	29.26	30.02	−.08	25.4	+1.7	52	24	31	0	8	19	38	24	20	78	2.02	+.1	12	10.9	w.	32	sw.	30	4	4	23	8.0	6.3	.0
Green Bay	617	109	141	29.30	30.01	−.05	15.4	−.3	39	23	23	−14	31	8	30	15	12	81	2.06	+.5	13	10.7	w.	34	nw.	24	6	5	20	7.7	17.2	14.3
Milwaukee	681	97	221	29.23	29.99	−.09	21.8	+1.2	41	21	28	−6	31	16	36	21	17	80	4.60	+2.8	12	12.5	nw.	35	nw.	24	2	4	25	8.4	7.8	.4
Duluth	1,133	5	47	28.74	30.03	−.06	8.6	+.7	40	23	16	−24	31	1	26	7	4	82	1.55	+.6	12	14.3	nw.	54	nw.	24	9	5	17	6.4	19.5	11.6
North Dakota							**9.4**	**+4.4**										**86**	**0.50**	**0.0**										**6.6**		
Moorhead, Minn	940	50	58	29.03	30.11	−.03	6.3	+2.5	37	23	15	−21	31	−2	30	6	5	90	.48	−.2	8	9.1	s.	28	n.	24	6	8	17	7.0	5.8	4.5
Bismarck	1,674	8	57	28.21	30.09	−.04	12.5	+4.7	41	23	22	−23	30	2	38	12	8	82	.40	.0	10	7.7	nw.	30	nw.	24	9	7	15	6.0	6.7	4.2
Devils Lake	1,478	11	44	28.43	30.10	−.02	4.6	+2.8	34	23	13	−31	31	−4	31	5	2	87	.27	−.2	9	8.3	nw.	25	n.	24	7	6	18	6.9	2.5	4.8
Grand Forks	833	12	67																													
Williston	1,878	42	50	28.00	30.08	−.03	14.1	+7.7	39	21	24	−23	30	5	44	13	10	86	.83	+.3	9	7.4	w.	25	nw.	11	8	8	15	6.4	10.8	9.3
Upper Mississippi Valley							**23.8**	**+2.0**										**77**	**2.22**	**+0.6**										**6.4**		
Minneapolis-St. Paul, Minn	919	105	208	29.01	30.04	−.07	13.5	+.8	47	23	20	−14	27	7	32	12	9	79	.87	.0	11	11.0	nw.	35	nw.	24	8	8	15	6.1	9.3	3.5
La Crosse	714	11	48	29.25	30.06	−.05	18.0	+1.9	47	22	25	−9	31	11	29	16	11	75	1.13	.0	9	6.4	nw.	21	nw.	24	6	9	16	6.7	9.2	3.0
Madison	974	70	78	28.92	30.03	−.07	17.8	+1.1	41	22	24	−10	31	11	35	17	14	82	2.81	+1.4	16	9.0	nw.	31	nw.	24	2	12	17	7.5	11.8	7.0
Charles City	1,015	10	51	28.93	30.08	−.06	15.8	+2.1	41	22	24	−13	10	8	32	15	12	84	1.13	+.1	12	7.1	nw.	25	nw.	24	9	10	12	5.8	8.9	3.0
Davenport	606	66	161	29.37	30.06	−.06	23.6	+1.8	44	23	31	−3	31	16	45	22	19	81	2.70	+1.3	10	10.5	nw.	33	nw.	24	10	6	15	6.3	5.3	T
Des Moines	861	5	99	29.12	30.07	−.07	22.6	+2.5	50	22	31	−6	31	14	39	21	16	75	.83	−.2	10	10.5	nw.	37	nw.	24	8	8	15	6.2	9.0	.3
Dubuque	699	60	79	29.26	30.05	−.07	20.0	+.9	46	22	27	−7	31	13	32	19	15	77	2.05	+.8	13	6.9	nw.	24	nw.	25	7	8	16	6.5	6.2	1.5
Keokuk	614	64	78	29.38	30.07	−.07	27.6	+2.7	54	16	36	−2	31	19	46	24	18	70	3.73	+2.2	10	8.6	nw.	30	nw.	30	10	4	17	6.3	2.1	.0
Cairo	358	87	93	29.69	30.09	−.07	37.3	+2.4	62	16	46	12	31	29	36	33	28	72	4.27	+.5	7	10.0	s.	32	sw.	24	11	3	17	6.1	1.1	.0
Peoria	609	11	45	29.36	30.05	−.07	26.2	+3.1	53	24	34	−1	31	18	45	24	21	84	4.32	+2.5	10	7.9	w.	24	w.	25	9	4	18	6.4	6.3	.0
Springfield, Ill	636	5	191	29.34	30.05	−.08	29.2	+2.7	55	24	37	2	31	21	42	27	23	78	1.53	−.6	8	12.5	nw.	32	nw.	25	9	4	18	6.6	1.7	.0
St. Louis	568	179	303	29.44	30.06	−.08	33.4	+2.3	62	16	42	5	31	25	45	30	24	70	1.31	−1.0	8	13.4	w.	35	sw.	30	9	7	15	6.0	1.1	.0
Missouri Valley							**27.0**	**+3.6**										**72**	**1.36**	**+0.3**										**5.8**		
Columbia, Mo	784	6	66	29.20	30.06	−.07	32.4	+3.2	62	16	41	1	31	23	48				3.34	+1.4	7	9.2	w.	30	nw.	24	10	4	17	6.1	.3	.0
Kansas City [1]	750	32	45	29.25	30.08	−.07	32.0	+3.8	60	28	41	2	31	24	37	28	22	68	1.89	+.7	5	11.3	sw.	39	nw.	25	10	7	14	5.8	.2	T
St. Joseph	967	11	49	29.01	30.08		29.8		60	28	38	−1	31	21	40	26	20	68	1.22	−.1	4	10.1	nw.	34	nw.	25	12	7	12	5.2	T	.0
Springfield, Mo	1,324	98	104	28.63	30.07	−.07	35.8	+2.3	68	16	45	3	31	27	49	31	26	72	3.14	+.8	6	11.3	nw.	32	w.	25	8	13	10	5.6	T	.0
Topeka	987	65	87	29.00	30.09		32.1	+4.5	66	28	42	1	31	23	46	28	22	67	1.14	+.2	4	10.3	nw.	35	nw.	24	10	12	9	5.3	.1	.0
Lincoln	1,189	11	81	28.77	30.08	−.07	27.2	+4.4	59	22	37	−5	31	17	38	24	16	64	.87	+.2	6	11.3	nw.	43	nw.	24	10	9	12	5.4	6.9	4.2
Omaha [1]	982	31	44	28.99	30.09	−.06	24.5	+2.6	55	22	34	−8	31	15	33	22	17	74	.68	.0	5	12.2	nw.	45	nw.	24	11	7	13	6.1	8.7	2.0
Valentine	2,598	47	54	27.29	30.11	−.01	25.4	+6.5	62	15	36	−13	30	15	43	22	18	75	.43	.0	11	9.7	w.	41	nw.	11	6	8	17	6.7	4.2	.8
Sioux City	1,138	64	106	28.82	30.09	−.06	20.3	+2.5	52	22	29	−11	30	12	41	19	14	76	.49	−.2	7	11.0	nw.	45	nw.	24	8	10	13	6.3	7.4	1.8
Huron	1,307	59	74	28.65	30.12	−.04	13.7	+2.4	41	22	23	−19	27	5	36	13	9	82	.43	−.1	8	9.2	nw.	33	nw.	24	9	7	15	6.0	8.1	1.8
Northern Slope							**25.5**	**+5.8**										**71**	**0.58**	**−0.2**										**6.6**		
Havre	2,507	11	67	27.36	30.08	−.02	24.3	+11.4	58	14	36	−27	30	12	41	21	16	69	.38	−.4	6	9.8	w.	30	w.	22	8	8	15	6.3	7.5	2.5
Helena	4,124	85	111	25.83	30.16	+.01	26.6	+6.4	49	14	34	−21	30	19	30	23	16	62	.54	−.3	6	8.6	sw.	35	sw.	12	6	4	21	7.3	11.1	3.8
Missoula	3,263	80	91				25.5	+3.2	47	10	32	−4	30	20	24				.59	−.4	16	5.8	se.	39	e.	28	4	1	26	8.2	7.8	3.5
Kalispell	2,973	48	56	27.02	30.19	+.07	25.2	+4.8	43	10	31	−11	30	19	21	24	21	84	.71	−.9	14	4.6	w.	29	n.	28	3	7	21	7.8	8.6	3.4
Miles City	2,371	48	55	27.49	30.06	−.06	23.8	+9.3	47	27	34	−23	30	14	34	22	18	76	.31	−.4	5	6.3	s.	31	nw.	11	4	9	18	7.3	2.4	2.5
Rapid City	3,259	50	58	26.59	30.06	−.04	29.0	+7.0	60	15	39	−13	30	19	36	25	21	77	.35	−.1	7	8.8	n.	32	nw.	11	9	11	11	5.7	4.2	1.9
Cheyenne [1]	6,144	5	39	23.89	30.08	+.03	27.4	+1.9	54	15	38	−9	30	17	44	23	17	64	.37	.0	3	16.0	nw.	45	nw.	18	7	13	11	5.7	4.3	T
Lander	5,352	60	68	24.63	30.17	+.05	22.1	+3.8	52	22	35	−12	30	9	47	18	10	61	.63	+.1	6	4.9	sw.	27	w.	22	9	13	9	5.3	9.0	2.5
Sheridan	3,790	10	47	26.09	30.12		24.8		48	22	36	−22	30	14	45	22	17	72	1.03	+.2	9	5.7	nw.	27	nw.	10	7	9	15	6.3	8.3	3.0
Yellowstone Park	6,241	12	46	23.88	30.26	+.12	20.5	+2.8	42	15	30	−19	30	12	43	18	13	70	1.41	+.6	17	8.0	s.	28	sw.	31	7	2	22	7.2	20.7	5.5
North Platte	2,821	11	51	27.07	30.09	−.03	30.2	+7.3	62	15	42	−7	30	19	37	25	20	72	.07	−.3	3	8.7	w.	30	n.	24	8	13	10	5.7	1.1	T

[1] Observations taken at airport.

TABLE 2.—*Climatological data for Weather Bureau stations, January 1938*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 inch or more	Wind: Average hourly velocity	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F		°F	°F.		°F	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
Middle Slope							**35.4**	**+5.0**										**57**	**0.43**	**−0.2**										**4.4**		
Denver	5,292	106	113	24.70	30.07	+0.02	34.9	+5.1	67	15	46	−3	30	24	48	27	15	48	0.77	+0.4	6	8.0	s.	30	ne.	11	9	15	7	5.0	10.4	0.0
Pueblo	4,685	80	86	25.29	30.08	+.03	33.8	+3.9	67	15	47	4	7	20	51	28	19	59	.62	+.3	4	7.4	nw.	40	w.	16	16	9	6	4.3	7.3	.0
Concordia	1,392	50	58	28.57	30.10	−.04	31.4	+5.0	67	28	42	−2	31	21	45	26	19	65	.16	−.4	3	9.7	n.	33	n.	24	13	13	5	4.5	.2	T
Dodge City	2,509	10	86	27.41	30.08	−.03	35.8	+6.8	67	15	48	1	31	23	36	28	16	51	.01	−.4	1	11.8	nw.	38	nw.	13	16	7	8	4.1	.1	.0
Wichita	1,358	85	93	28.62	30.09	−.04	35.6	+4.3	66	16	46	3	31	25	38	30	21	58	.12	−.7	3	10.4	nw.	30	nw.	24	17	7	7	3.8	T	.0
Oklahoma City	1,214	10	47	28.78	30.10	−.01	41.0	+4.6	73	16	51	9	31	31	35	35	27	61	.92	−.3	3	10.6	s.	30	nw.	24	14	9	8	4.7	T	.0
Southern Slope							**45.9**	**+3.1**										**58**	**1.05**	**+0.4**										**5.0**		
Abilene	1,738	10	52	28.26	30.11	+.02	48.4	+4.2	84	16	58	17	31	38	33	40	32	61	1.49	+.5	6	9.6	s.	29	s.	28	10	7	14	5.6	.0	.0
Amarillo	3,676	10	49	26.29	30.08	+.02	40.8	+5.5	75	15	53	11	31	29	43	32	20	48	.18	−.3	2	9.8	sw.	30	w.	29	10	14	7	5.0	.7	.0
Del Rio	960	63	71	29.07	30.08	+.02	53.1	+.8	85	18	62	28	31	44	37	47	41	69	1.38	+.8	5	8.4	se.	35	nw.	24	9	9	13	5.6	.0	.0
Roswell	3,566	75	85	26.42	30.10	+.06	41.2	+2.0	75	19	55	19	26	28	51	34	24	56	1.15	+.6	4	7.6	s.	35	nw.	23	16	9	6	4.0	6.3	.0
Southern Plateau							**43.8**	**+3.7**										**52**	**0.56**	**−0.4**										**3.5**		
El Paso	3,778	82	101	26.25	30.08	+.07	47.2	+2.2	71	19	58	25	25	36	33	38	27	50	1.22	+.8	5	7.6	nw.	27	w.	29	16	9	6	3.5	.0	.0
Albuquerque [1]	4,972	5	39	25.09	30.11	------	36.0	+1.9	60	18	50	12	25	22	39	29	21	61	.12	−.3	2	7.8	n.	44	nw.	23	17	5	9	4.1	T	.0
Santa Fe	7,013	38	53	23.23	30.10	+.06	31.7	+2.9	56	22	42	7	24	22	33	26	16	55	.03	−.6	1	6.3	n.	24	w.	29	14	6	11	4.8	.4	.0
Flagstaff	6,907	10	59	23.35	30.01	−.04	34.2	+7.5	59	13	46	13	8	22	40	30	----	65	1.39	−1.4	5	9.0	sw.	28	nw.	9	12	10	9	----	5.5	T
Phoenix	1,107	39	51	28.88	30.05	+.02	55.0	+3.8	77	13	69	31	25	41	39	45	32	47	.52	−.3	4	5.2	e.	23	w.	15	20	6	5	2.9	.0	.0
Yuma	141	9	54	29.92	30.07	+.02	58.4	+4.0	77	27	71	35	30	46	35	46	30	37	.07	−.4	2	6.6	n.	27	nw.	20	24	1	6	2.2	.0	.0
Independence	3,957	5	26	------	------	------	------	------	----	----	----	----	----	----	----	----	----	----	------	------	----	----	----	----	----	----	----	----	----	----	----	----
Middle Plateau							**32.8**	**+5.0**										**73**	**0.94**	**−0.1**										**5.9**		
Reno	4,527	61	76	25.56	30.18	+.05	36.4	+4.8	61	14	46	18	24	27	31	32	26	68	.66	−.9	7	5.5	sw.	32	s.	31	7	11	13	5.8	1.7	T
Tonopah	6,090	12	20	------	------	------	------	------	----	----	----	----	----	----	----	----	----	----	------	------	----	----	----	----	----	----	----	----	----	----	----	----
Winnemucca	4,344	18	56	25.73	30.22	+.06	32.7	+4.1	54	22	41	13	24	24	27	30	27	84	1.16	+.1	6	7.8	ne.	30	nw.	22	6	7	18	6.9	6.1	.0
Modena	5,473	10	43	24.68	30.15	+.05	29.6	+2.9	56	14	41	0	21	19	36	26	22	74	1.38	+.5	7	8.0	w.	31	sw.	15	11	6	14	5.5	10.4	T
Salt Lake City [1]	4,227	32	46	25.83	30.18	+.03	35.7	------	59	14	45	16	25	27	34	31	26	71	.55	------	6	8.0	se.	38	nw.	22	8	8	15	6.0	2.4	.0
Grand Junction	4,602	60	68	25.47	30.14	+.08	32.4	+8.4	49	14	41	15	25	23	25	28	23	70	.58	.0	6	5.0	se.	27	s.	16	9	13	9	5.3	4.0	.0
Northern Plateau							**33.6**	**+5.8**										**77**	**1.12**	**−0.6**										**8.0**		
Baker	3,471	36	54	26.55	30.22	+.06	32.9	+8.0	51	10	40	16	6	26	26	30	27	79	.53	−.9	9	5.6	s.	23	n.	12	3	5	23	8.0	5.3	T
Boise	2,739	79	87	27.31	30.24	+.05	35.9	+6.1	51	31	43	22	5	29	21	33	29	74	1.51	−.2	11	5.3	se.	27	nw.	12	6	5	20	7.1	.6	.0
Pocatello	4,477	60	68	25.55	30.18	−.02	31.4	+6.7	53	15	38	13	27	25	29	28	24	72	1.08	−.3	8	9.5	se.	32	sw.	10	5	13	13	6.8	3.4	T
Spokane	1,929	101	110	28.09	30.20	+.08	31.5	+4.0	47	14	36	9	30	27	16	30	27	81	1.44	−.7	15	6.2	s.	22	s.	22	4	4	23	8.4	6.2	3.6
Walla Walla	991	57	65	29.11	30.21	+.06	36.4	+3.7	61	14	41	17	30	32	21	34	31	80	1.41	−.6	13	5.3	s.	31	w.	10	1	3	27	9.1	7.1	5.4
Yakima	1,076	58	67	29.02	30.20	------	33.6	+6.2	56	15	39	19	31	28	22	32	28	78	.74	−.6	9	3.9	nw.	19	nw.	22	3	5	23	8.4	2.8	2.0
North Pacific Coast Region							**42.5**	**+2.3**										**83**	**4.65**	**−2.0**										**8.2**		
North Head	211	11	56	29.87	30.10	+.05	45.4	+3.3	61	25	50	34	31	41	17	43	41	84	5.28	−3.5	21	13.5	e.	61	s.	20	3	12	16	7.5	.0	.0
Seattle	125	90	321	29.96	30.10	+.05	42.5	+3.0	53	25	47	30	7	38	17	39	40	80	3.81	−1.1	12	8.1	se.	40	sw.	22	3	8	20	7.8	1.3	.2
Tatoosh Island	86	10	54	29.96	30.06	+.08	44.0	+2.8	50	11	47	31	30	41	10	42	39	81	6.62	−5.2	21	19.4	e.	52	e.	29	2	7	22	8.2	.5	T
Medford [1]	1,329	29	58	28.73	30.18	------	38.4	+.5	57	25	44	25	24	33	29	37	36	90	2.83	.0	16	------	w.	----	----	----	1	4	26	8.7	T	.0
Portland, Oreg.	153	68	106	29.98	30.14	+.06	41.4	+2.0	56	14	46	26	6	36	23	39	36	79	5.06	−1.5	18	6.0	se.	19	ne.	30	1	9	21	8.1	.9	T
Roseburg	510	45	76	29.59	30.15	+.05	43.4	+2.2	60	21	49	30	25	38	27	42	39	83	4.32	−1.0	18	3.9	s.	18	sw.	17	1	4	26	8.7	.0	.0
Middle Pacific Coast Region							**49.0**	**+2.0**										**78**	**4.81**	**−0.7**										**6.3**		
Eureka	62	73	89	30.07	30.14	+.04	49.9	+3.0	65	11	56	36	24	44	22	47	44	81	6.28	−.8	18	6.9	se.	27	se.	30	8	7	16	6.4	.0	.0
Redding [1]	722	20	34	------	------	------	49.2	+3.9	74	10	58	28	6	41	33	44	38	70	6.81	.0	14	7.0	nw.	30	se.	31	6	9	16	6.7	.0	.0
Sacramento	66	92	115	30.08	30.16	+.04	45.3	−.5	60	26	51	32	24	40	24	43	41	84	3.50	−.2	13	6.5	se.	31	se.	31	8	5	18	6.9	.0	.0
San Francisco	155	112	132	29.95	30.12	+.01	51.4	+1.5	66	26	57	40	7	46	20	48	44	77	2.65	−1.9	12	7.0	n.	26	se.	16	10	11	10	5.2	.0	.0
South Pacific Coast Region							**55.4**	**+3.7**										**65**	**1.55**	**−0.7**										**5.3**		
Fresno	327	97	105	29.81	30.17	+.07	46.6	+.4	65	26	54	32	12	40	28	45	42	84	2.14	+.4	9	5.2	nw.	22	e.	31	4	6	21	7.5	.0	.0
Los Angeles	338	159	191	29.71	30.08	.00	61.2	+6.6	82	26	70	44	30	52	28	50	39	50	1.63	−1.5	7	5.8	ne.	21	nw.	20	17	6	8	4.0	.0	.0
San Diego	87	62	70	29.97	30.06	−.01	58.4	+4.1	79	12	68	42	30	49	29	50	43	61	.89	−1.2	6	5.5	nw.	27	w.	19	18	3	10	4.4	.0	.0
West Indies																																
San Juan, P. R.	82	9	54	29.94	30.04	------	75.1	+.1	80	19	79	68	11	72	11	----	----	----	2.08	−2.1	17	14.8	e.	35	ne.	30	0	25	6	6.2	.0	.0
Panama Canal																																
Balboa Heights	118	6	92	------	[3]29.81	+.01	79.6	−.3	90	23	88	69	28	72	19	----	----	[2]78	2.20	+1.2	7	7.4	nw.	24	n.	26	7	24	0	4.6	.0	.0
Cristobal	36	6	97	------	[3]29.87	+.01	80.8	−.7	86	20	85	74	25	77	11	74	72	[2]77	2.27	−1.2	20	13.2	n.	28	ne.	28	6	20	5	5.4	.0	.0
Alaska																																
Fairbanks	454	11	87	------	[3]29.97	------	−18.1	−6.0	22	7	−9	−43	1	−27	39	----	----	80	.54	−.3	7	3.6	n.	27	w.	9	13	5	13	----	15.4	19.0
Juneau	80	96	116	[3]29.71	[3]29.80	------	31.9	+4.5	46	4	35	13	31	28	17	29	24	74	10.30	+3.3	25	9.4	s.	32	se.	2	5	1	25	8.4	35.0	5.5
Nome	22	5	32	[3]29.94	[3]29.95	------	−.8	−4.5	25	28	7	−26	4	−9	29	0	−7	67	.54	−.6	5	7.9	ne.	36	ne.	15	18	5	8	4.1	6.5	5.6
Hawaiian Islands																																
Honolulu	38	86	100	29.96	30.00	------	72.8	+1.9	81	31	78	63	10	68	15	66	63	73	2.15	−1.6	13	9.1	e.	30	e.	25	11	12	8	5.1	.0	.0

[1] Observations taken at airport. [2] Observations taken hourly. [3] Pressure not reduced to a mean of 24 hours.

TABLE 3.—*Data furnished by the Canadian Meteorological Service, January 1938*

Stations	Altitude above mean sea level, Jan. 1, 1919	Pressure			Temperature of the air						Precipitation		
		Station reduced to mean of 24 hours	Sea level reduced to mean of 24 hours	Departure from normal	Mean max. + mean min. ÷2	Departure from normal	Mean maximum	Mean minimum	Highest	Lowest	Total	Departure from normal	Total snowfall
	Feet	In.	In.	In.	°F.	°F.	°F.	°F.	°F.	°F.	In.	In.	In.
Cape Race, Newfoundland	99												
Sydney, Cape Breton Island	48	29.93	29.99	+0.05	24.2	+2.5	31.5	16.8	50	4	2.78	−2.31	6.2
Halifax, Nova Scotia	88	29.77	30.05	+.07	24.3	+1.3	30.7	17.9	50	−5	4.50	−1.04	3.1
Yarmouth, Nova Scotia	65	29.93	30.04	+.04	27.0	+.2	33.5	20.6	49	6	4.69	−.19	13.6
Charlottetown, Prince Edward Island	38	29.95	30.04	+.08	18.2	+1.0	25.1	11.4	48	−4	2.45	−1.69	11.8
Chatham, New Brunswick	28	29.87	29.99	+.01	13.4	+.7	24.5	2.3	46	−18	2.33	−1.10	9.3
Father Point, Quebec	20	29.97	29.99	+.01	12.6	+3.6	21.1	4.0	49	−11	2.59	+.09	21.3
Quebec, Quebec	296	29.69	30.03	−.01	11.8	+2.1	18.4	5.1	49	−17	3.63	−.20	25.9
Doucet, Quebec	1,236	28.56	30.00	−.04	−.6	+1.8	11.1	−12.2	38	−48	3.97	+1.29	36.7
Montreal, Quebec	187												
Ottawa, Ontario	236	29.76	30.02	−.04	9.6	−1.8	19.2	.3	44	−25	1.92	−1.04	11.3
Kingston, Ontario	285	29.68	30.02	−.05	18.0	−.2	25.8	10.3	46	−11	1.88	−.95	8.2
Toronto, Ontario	379	29.58	30.02	−.06	22.3	−.4	28.7	15.9	47	−4	1.63	−1.09	9.7
Cochrane, Ontario	930	28.90	29.99	−.09	−1.3	−1.5	7.2	−9.8	36	−33	4.84	+3.34	48.4
White River, Ontario	1,244	28.60	30.02	.00	−3.9	−3.8	10.8	−18.6	37	−52	3.07	+1.43	30.7
London, Ontario	808	29.08	29.99	−.11	19.4	−3.0	27.0	11.7	45	−4	2.56	−1.38	18.5
Southampton, Ontario	656	29.24	29.98	−.06	18.8	−2.5	25.1	12.4	45	−11	3.72	−.06	28.3
Parry Sound, Ontario	688	29.26	30.00	−.04	13.2	−1.5	21.9	4.6	43	−20	4.17	+.15	30.3
Port Arthur, Ontario	644	29.30	30.06	−.01	4.4	−2.2	13.6	−4.8	34	−28	1.90	+1.12	19.0
Winnipeg, Manitoba	760	29.22	30.12	−.05	−.6	+2.0	8.9	−10.0	30	−41	1.36	+.49	13.6
Minnedosa, Manitoba	1,690	29.16	30.10	−.02	1.1	+3.5	10.0	−7.8	29	−36	.66	−.15	6.6
Le Pas, Manitoba	860	29.06	30.10	−.05	−5.2	+2.1	3.0	−13.4	34	−38	.28	−.26	2.8
Qu'Appelle, Saskatchewan	2,115	27.66	30.06	−.08	5.2	+4.4	14.3	−4.0	34	−35	1.58	+.87	15.8
Moose Jaw, Saskatchewan	1,759	27.97	30.05	−.08	11.0	+7.0	20.3	1.7	40	−30	1.00	+.36	9.5
Swift Current, Saskatchewan	2,392	27.38	30.08	−.05	16.0	+9.1	23.4	8.5	40	−27	.92	+.24	9.2
Medicine Hat, Alberta	2,365	27.45	30.04	−.08	22.8	+10.2	31.4	14.2	48	−24	.88	+.27	8.8
Calgary, Alberta	3,540	26.26	30.08	+.02	22.6	+11.3	31.7	13.4	46	−21	.15	−.34	1.5
Banff, Alberta	4,521	25.28	30.06	−.02	16.8	+3.4	25.8	7.7	43	−33	1.02	−.38	10.2
Prince Albert, Saskatchewan	1,450	28.46	30.10	−.02	.8	+4.9	10.4	−8.7	36	−46	1.04	+.29	10.4
Battleford, Saskatchewan	1,592	28.24	30.08	−.04	5.6	+9.4	15.2	−4.1	38	−36	.61	+.08	5.7
Edmonton, Alberta	2,150	27.62	30.02	−.04	14.9	+8.7	24.2	5.6	44	−32	.70	−.15	7.0
Kamloops, British Columbia	1,262												
Victoria, British Columbia	230	29.85	30.11	+.06	40.8	+2.2	44.1	37.5	51	28	2.51	−1.86	1.5
Barkerville, British Columbia	4,180												
Estevan Point, British Columbia	20												
Prince Rupert, British Columbia	170												
St. George's, Bermuda	158		30.07	−.06	63.8	+1.1	68.2	59.5	76	50	6.96	+2.34	.0
LATE REPORTS FOR DECEMBER 1937													
Cape Race, Newfoundland	99				32.2	+2.0	37.6	26.8	49	11	9.79	+4.73	15.5
Banff, Alberta	4,521	25.24	30.00	−0.08	15.4	−1.3	24.9	6.0	38	−29	3.11	+1.91	31.1

TABLE 4.—*Severe local storms, January 1938*

[Compiled by Mary O. Souder from reports submitted by Weather Bureau Officials]

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A revised list of tornadoes will appear in the United States Meteorological Yearbook]

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks
Rhode Island, entire State	1–2					Snow, sleet, and rain.	On the 1st snow and sleet turned to rain in the afternoon which lasted until about 8:45 a. m. of the 2d. At this time ½ inch of glaze had formed on streets and roadways. Numerous accidents reported in Providence.
Boise and Nampa, Idaho	12	2:45–3:25 p. m.	[1] 10		$5,000	Straight-line wind.	Number of sheds and outbuildings demolished; path 25 miles long.
Hartford, Conn	13					Snow	Considerable inconvenience to traffic of all types.
Albuquerque, N. Mex	15	A. m.				Glaze	Light mist falling on frozen surfaces caused a light glaze on sidewalks and streets. Several persons injured by falling. Glaze unusual in Albuquerque.
Dallas, Tex., and vicinity	20	1 p. m.		1		Rain, hail, and electrical.	Boy killed by lightning. Ground covered with hail in sections of Oak Cliff and Trinity Heights.
Rockford, Amboy, Kewanee, and La Salle, Ind., and vicinities.	23–24			3	600,000	Heavy rain and flood.	A considerable portion of the southeastern section was inundated to a depth of several feet, requiring 600 families to move, closing the industrial section. Because of rapidly rising water, many families had to be rescued from their homes. Minor loss to crops and livestock.
Dodge City, Kans	23–24			1		2 duststorms	Poor visibility caused 2 motor accidents. In the one on the 24th, 1 person was killed and 3 injured. On the 24th, the Santa Fe trains, on the branch line which runs through the heart of the dust bowl to Boise City, Okla., were unable to get through dust and sand drifts several feet deep and about one-quarter of a mile long over the tracks.
Kilby, Ala.[2]	24	p. m.		0		Tornado	Trees broken or unrooted; number of porches damaged; roof of a residence blown off. 2 or more main electric power lines damaged, throwing the entire village in darkness.
Evansville, Ind., and vicinity	24				1,000	Wind	Damage principally to windows and roofs.
Indianapolis, Ind	24					do	Power and telegraph wires and poles and trees damaged; windows broken; building unroofed.

[1] Miles instead of yards.

[2] From press reports.

TABLE 4.—*Severe local storms, January 1938*—Continued

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks
Grand Marais, Minn., and vicinity.	24–25				15,000	Blizzard	At Grand Marais, buildings were unroofed, windows broken, signs, awnings, poles and wires down, cabins toppled over, and trees uprooted. Heavy snows caused much drifting, delaying traffic in the northern and eastern portions of the State.
New York, N. Y	24–25					Wind	On the 24th a maximum wind velocity of 51 miles an hour with an extreme velocity of 61 miles was recorded. On the 25th the maximum wind velocity was 59 miles an hour with an extreme velocity of 67 miles. Several persons blown off their feet; property damaged.
Wisconsin, eastern portion	24–25					Rain, wind, and snow.	Heavy rain in the extreme southeastern portion caused moderate floods in small streams. At the same time blizzard conditions were experienced in the northeastern portion from Sheboygan northward. Many highways blocked, some until the 26th.
Duluth, Minn	24–26					Wind and snow	Property damaged; travel difficult, because of drifting snow. Trains and busses late, especially those from the south and east where heavier snowfall blocked the highways.
Marquette, Mich., and vicinity	24–27	6 a. m. of 24th – 3:20 p. m. of the 27th.				Blizzard	During this "old-time" blizzard, wind blew continuously. By 8 p. m. of the 24th, streets and highways were impassable. No trains in the city from the 25th to 27th. Full service resumed on the 28th, but with considerable delay. On the 25th and 26th there were no mail deliveries and delivery of food only in emergency cases was made by men on snowshoes. Drifts about the city 10 feet deep. In the vicinity of Negaunee there was a 17-foot drift on the main street. Electric service interrupted for a short period by falling trees. The Weather Bureau official at Marquette states that in his 28 years' experience in this section he had never seen such a combination of wet snow and high wind.
Evansville, Ind	24–28					Rain and snow	Dangerous condition in the streets and on highways; traffic interrupted.
Michigan, entire State	25			2		Blizzard	All roads blocked in Baraga, Marquette, Schoolcraft, Dickinson, and Delta Counties. Traffic at standstill throughout the western Upper Peninsula. Children kept all night in 2 rural schools near Ironwood. Schools closed quite generally in northern Lower Michigan and the Upper Peninsula. The Ann Arbor railroad car-ferry, No. 3, broke its moorings and drifted over to the south shore. Several fishing boats rescued by coast guards. 130 marooned motorists rescued. 60 river shacks blown into Lake Erie, near Monroe. More than 20 small buildings demolished in the St. Clair River and Lake region.
Norfolk, Va	25				2,800	Wind	Small damage to power and telephone lines. Several plate-glass windows blown in; number of trees uprooted. Several ships off the coast damaged and in distress.
Missoula, Mont.,[1] and vicinity	28	P. m.				do	High wind and snow caused limited visibility.
Cherokee and Crawford Counties, Kans.	29	11 p. m.			50,000	Wind and hail	In Cherokee County, hail caused chief damage; much plate glass broken; roofs damaged; loss $20,000. In Crawford County wind caused property damage to the extent of $30,000.
Iantha, Liberal, Irwin, and Oakton, Mo.,[1] and vicinities.	29	11:20 p. m.				Wind	Much damage to rural property.
Milwaukee, Wis	29–30					Rain and glaze	Heavy glaze on exposed objects.
Dubuque, Iowa, and vicinity	30–31					Glaze	3 persons injured when a Cedar Rapids-Dubuque bus overturned. Several other accidents reported. Highways dangerously icy in spots.

[1] From press reports.

U. S. GOVERNMENT PRINTING OFFICE: 1938

Chart I. Departure (°F.) of the Mean Temperature from the Normal, January 1938

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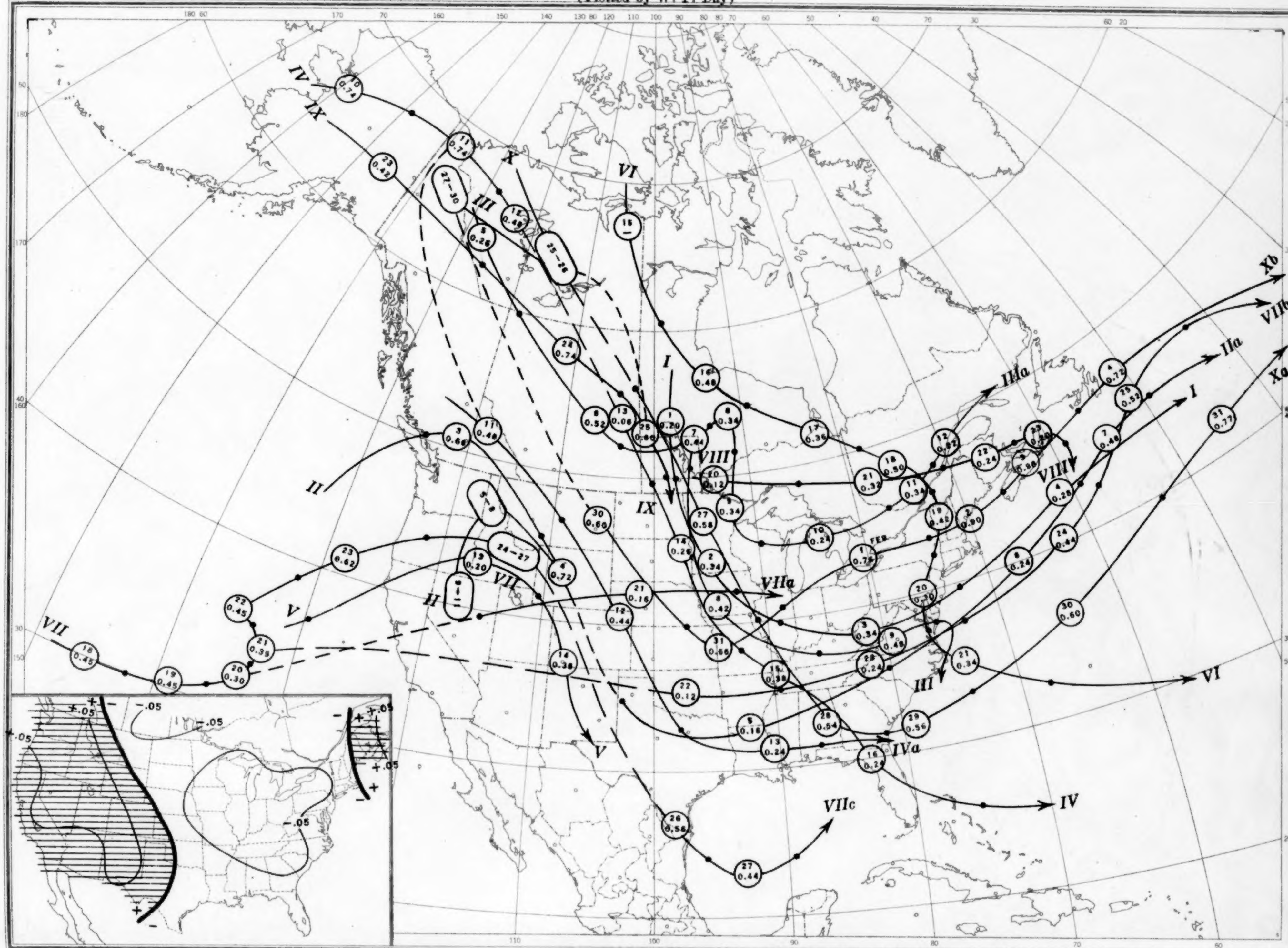
Chart II. Tracks of Centers of Anticyclones, January 1938. (Inset) Departure of Monthly Mean Pressure from Normal

(Plotted by W. P. Day)



Circle indicates position of anticyclone at 7:30 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 7:30 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, January 1938. (Inset) Change in Mean Pressure from Preceding Month

(Plotted by W. P. Day)

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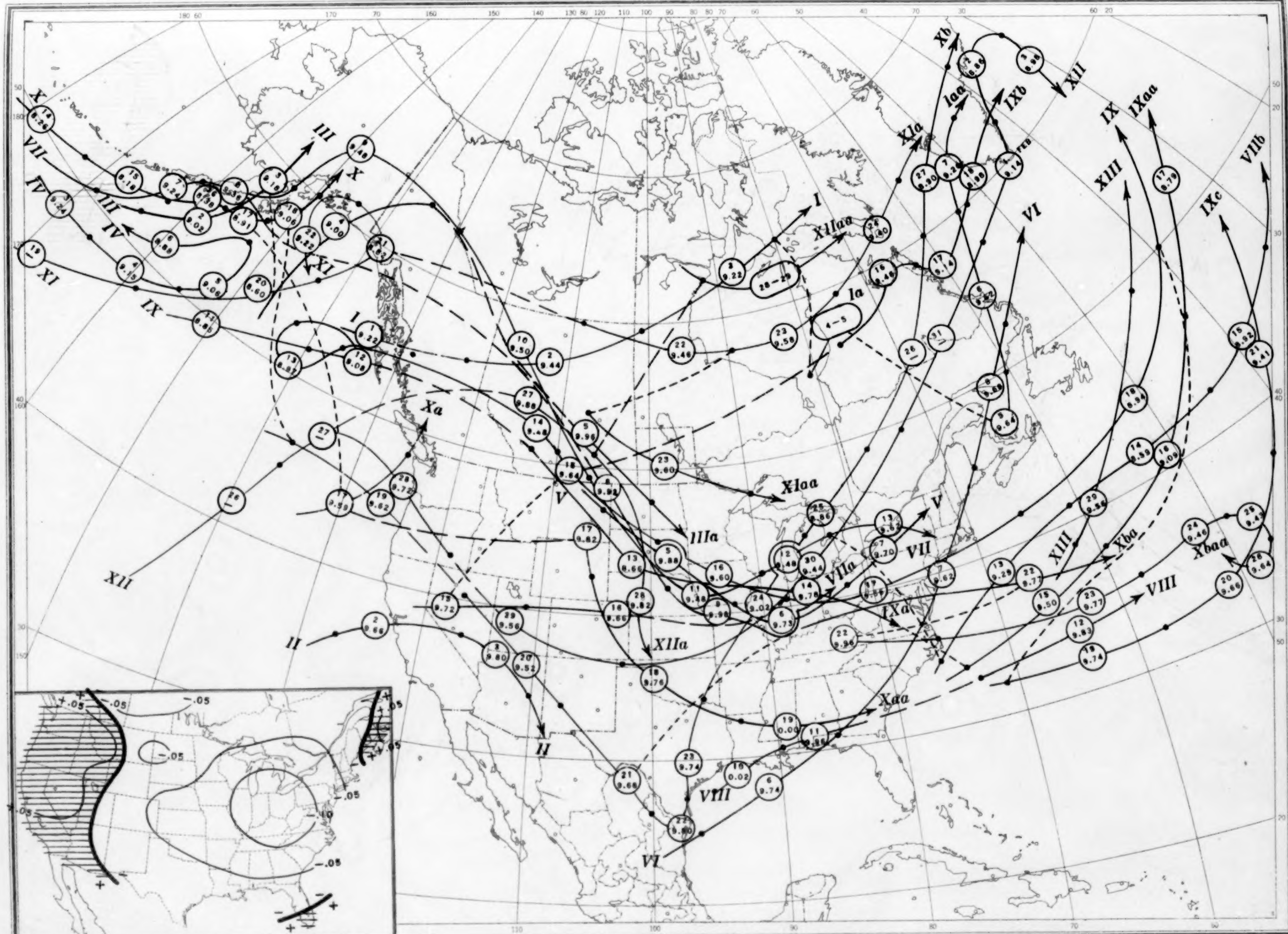
(Plotted by W. P. Day)



Circle indicates position of cyclone at 7:30 a. m. (75th meridian time), with barometric reading. Dot indicates position of cyclone at 7:30 p. m. (75th meridian time).

Chart IV. Percentage of Clear Sky Between Sunrise and Sunset, January 1938

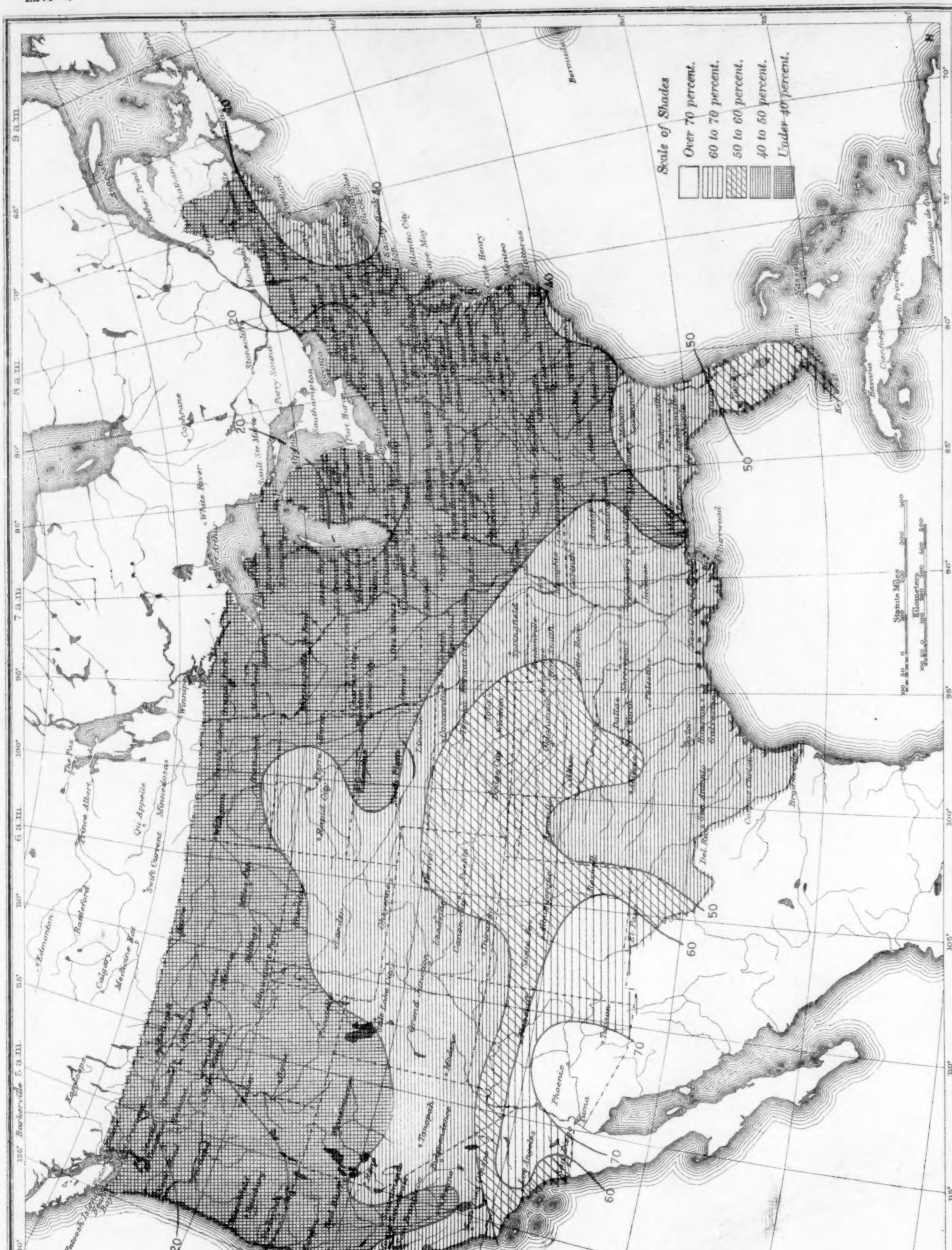


Chart V. Total Precipitation, Inches, January 1938. (Inset) Departure of Precipitation from Normal

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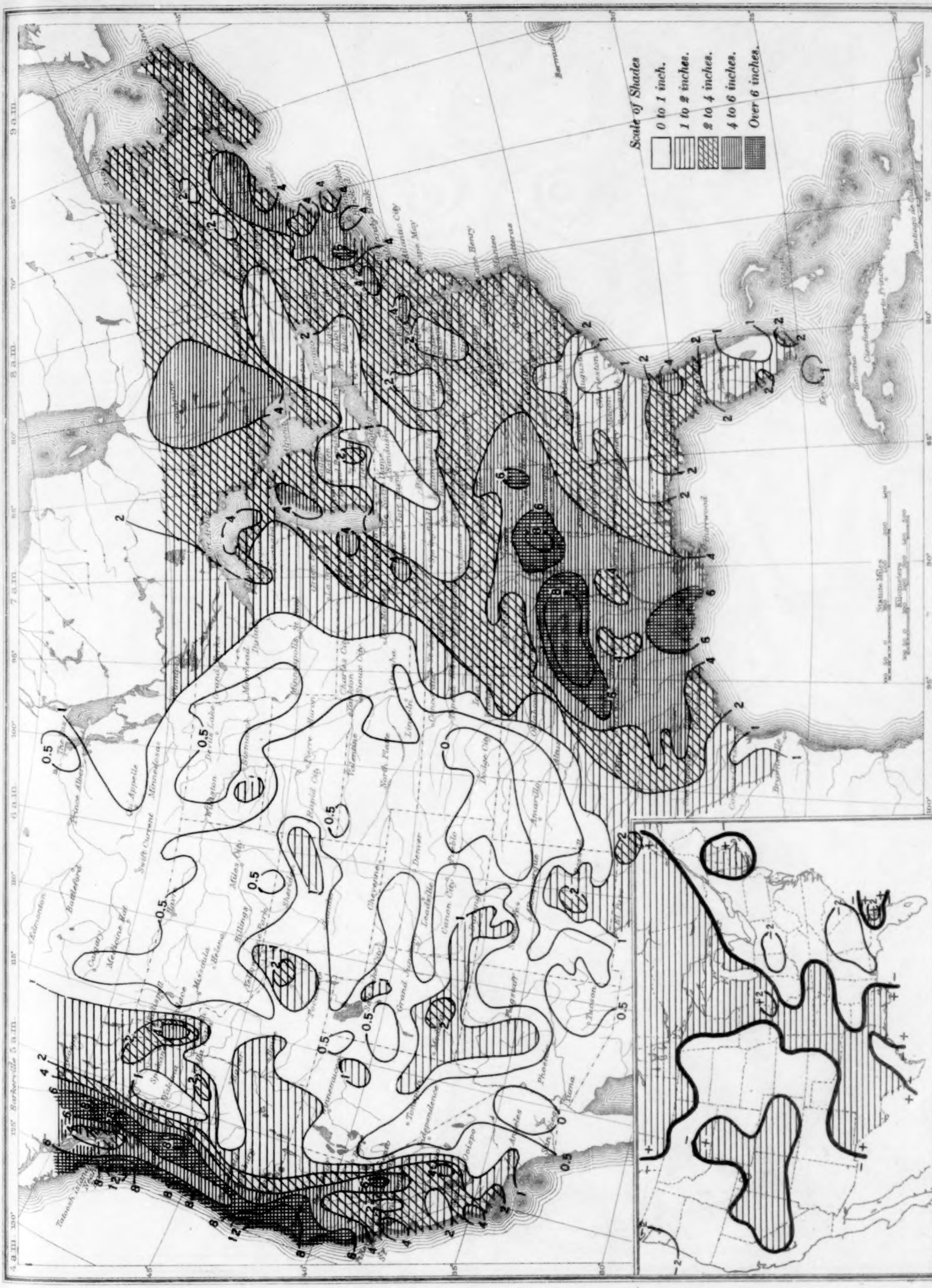

Chart VI. Isobars at Sea Level and Isotherms at Surface; Prevailing Winds, January 1938

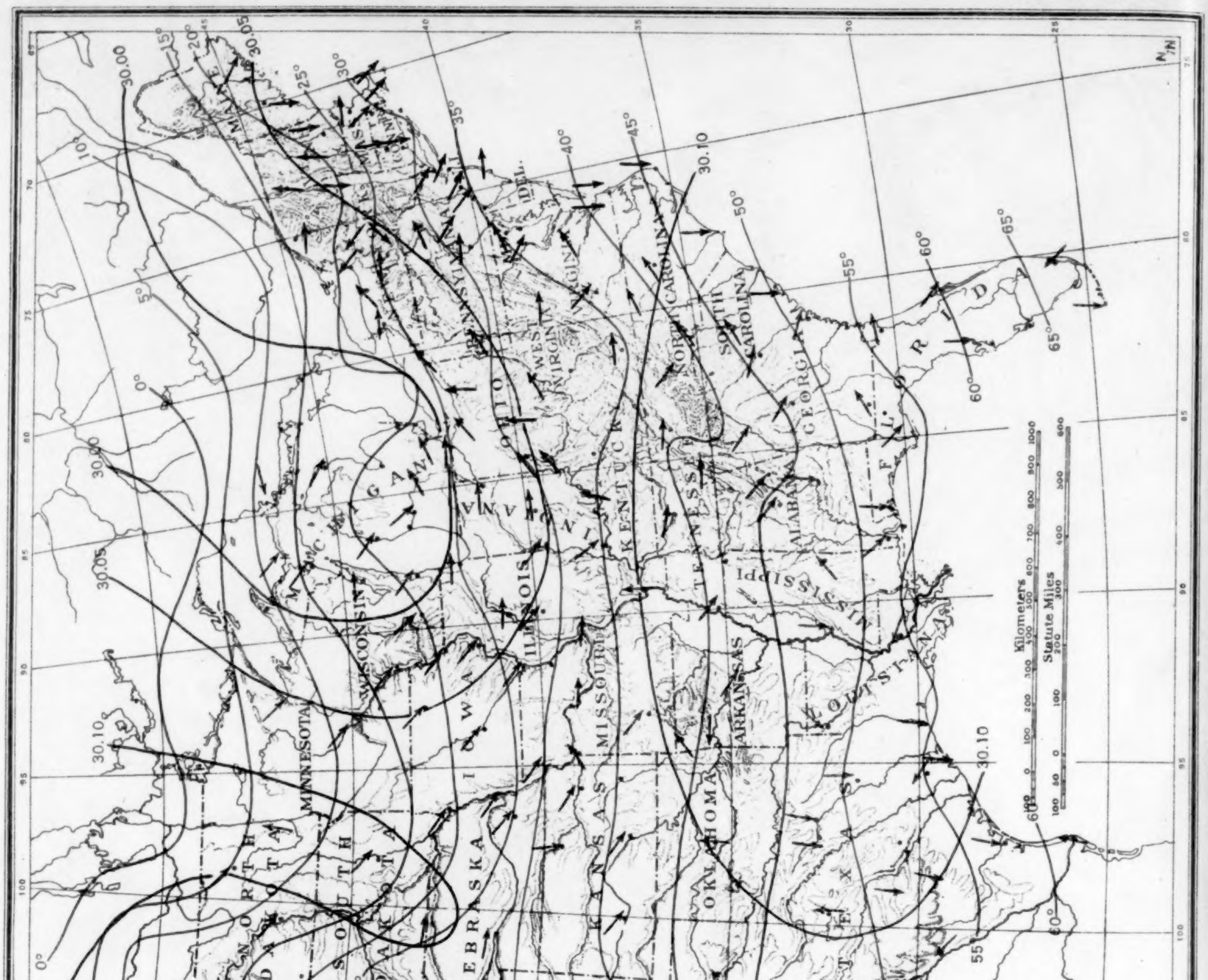

Chart VII. Wind Roses for Selected Stations, January 1938
(Plotted by W. W. Reed)

Chart VII. Wind Roses for Selected Stations, January 1938
(Plotted by W. W. Reed)

Chart VIII. Total Snowfall, Inches, Jan. 1938. (Inset) Depth of Snow on Ground at 7:30 p. m., Monday, January 31 1938

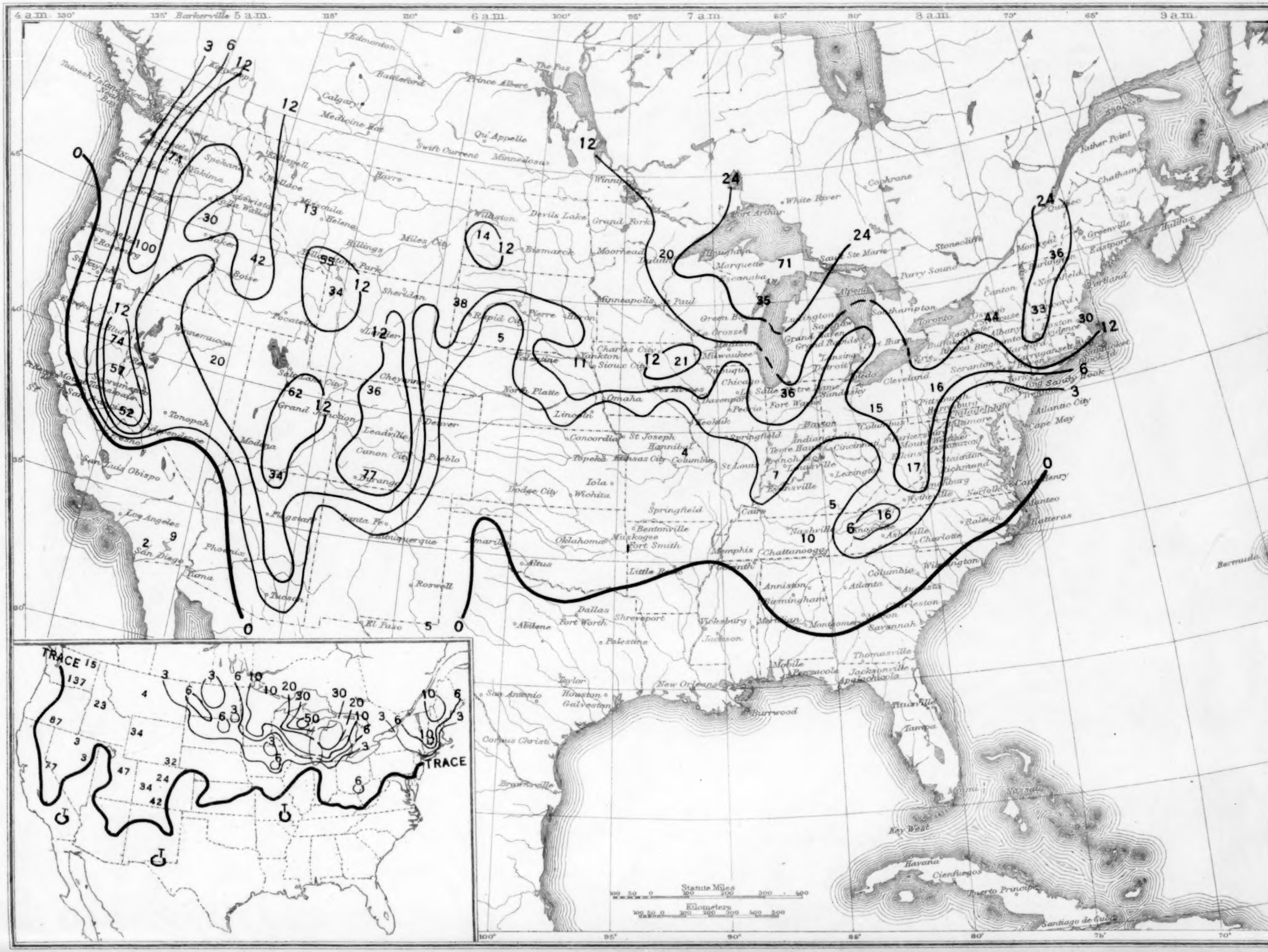

Chart IX. Weather Map of North Atlantic Ocean, January 14, 1938
(Plotted from the Weather Bureau Northern Hemisphere Chart)

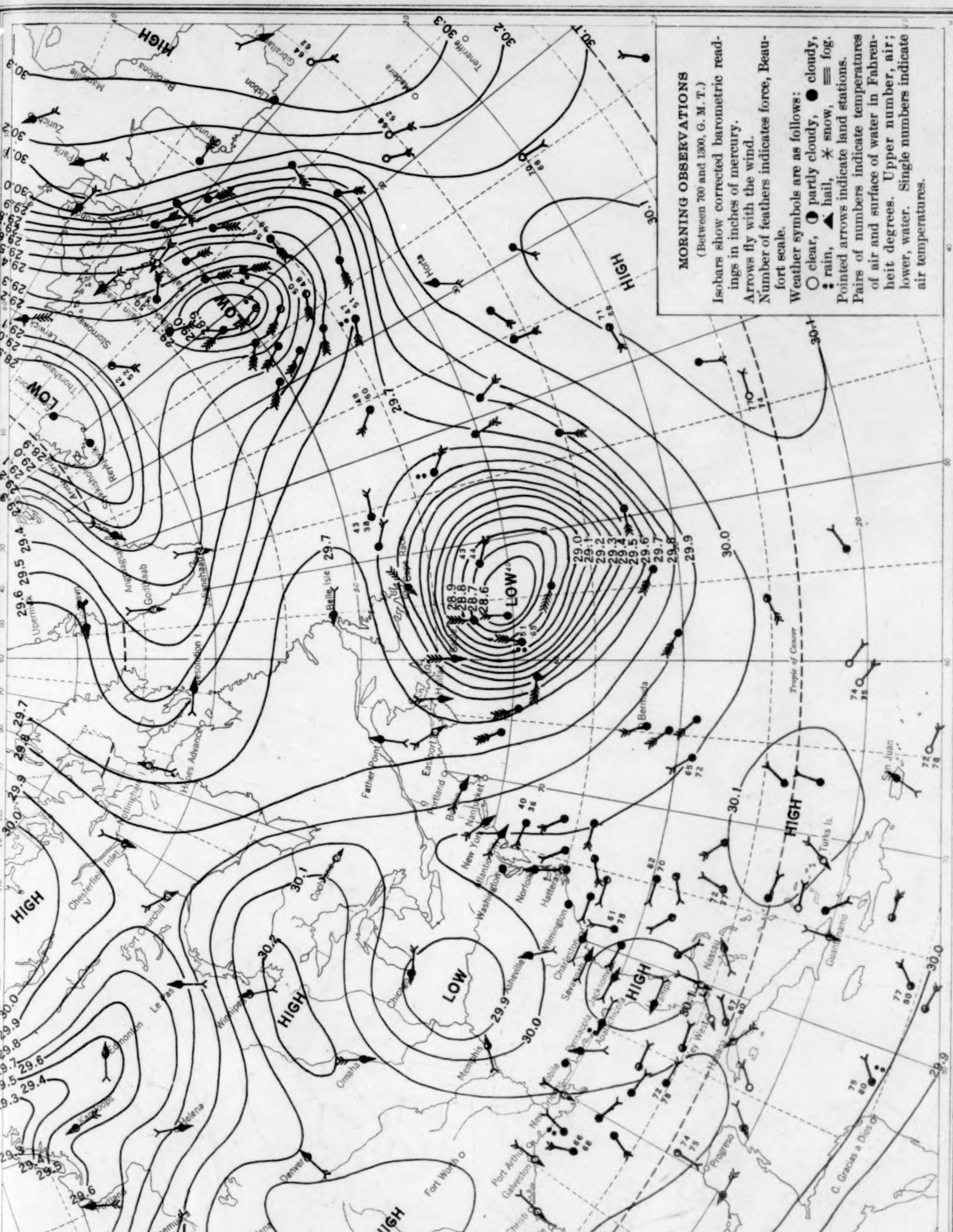

Chart X. Weather Map of North Atlantic Ocean, January 16, 1938

(Plotted from the Weather Bureau Northern Hemisphere Chart)

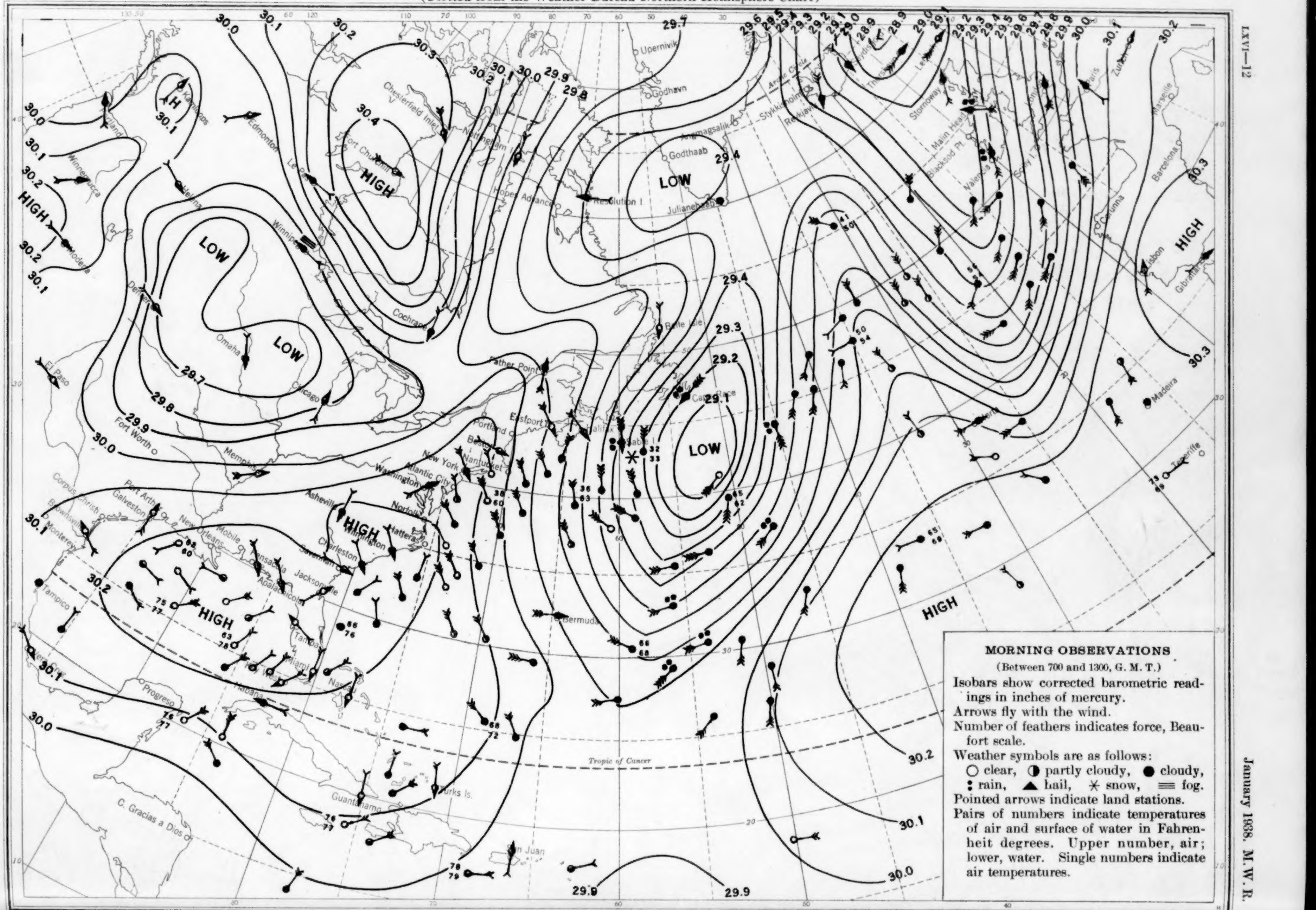

Chart XI. Weather Map of North Atlantic Ocean, January 28, 1938
(Plotted from the Weather Bureau Northern Hemisphere Chart)